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SHEFFIELD MEETING

PREVIOUS visits of the Association to Sheffield took place in 1879 and 1910. At the close of the 1910 meeting the *Sheffield Telegraph* reported, 'Everything has gone off well. Sheffield has risen to the occasion as it always does when it takes anything great in hand. The greater the occasion, the greater is always Sheffield's success.' The passage of years evidently has not altered the quality of Sheffield's pride nor diminished her vigour, for this verdict can hardly be bettered as a statement of the success which has attended this year's Meeting. To this success many things contributed: the enthusiasm and efficiency which distinguished the efforts of the Local Executive Committee in making their plans for the reception, accommodation and entertainment of members; the extreme generosity with which these arrangements were realised; and not least the considerable and varied attractions of Sheffield and the surrounding countryside.

Speaking at a Luncheon in the Town Hall at which, on the opening day of the Meeting, the City and the University entertained Officers of the Association, Sir Raymond Priestley, M.C., President of the Association, said:

'Sheffield is an ideal centre for this Meeting, for it is a major centre of industry—exceedingly active and dependent in almost every branch on the continuous application of scientific discovery. It is noted for the harmonious relations between the City, industry and University. Sheffield is a stimulating place for scientists to visit, as I found a month or two ago, when the Master Cutler and I were shown Hadfields Limited, and saw the production of their special alloy steels. It is particularly appropriate also that the Association should meet here in 1956, for this year is the Centenary of Bessemer's discovery which he announced to the world at the Cheltenham meeting of the Association in 1856 through a paper "On the Manufacture of Malleable Iron without Fuel". In 1859 he set up his works in Sheffield and he and his competitors produced steel at a quarter of its former cost and so ushered in the great steel age. . . .'

The Times, summarising its conclusions at the end of a memorable week, said, 'The Annual Meeting of the British Association which ended here today has been a remarkably successful performance. The final attendance of 3373 was the highest since the Liverpool Meeting in 1953.' Of this total, roughly 55 per cent were visitors to Sheffield, and 45 per cent were drawn from Sheffield and the surrounding districts; just over 900 were student members. The impressions of members, especially those visiting Sheffield for the first time, must have been, above all, of flourishing industries—for Sheffield with its population of nearly half a million is first and foremost an industrial City, whose proud boast is that it produces approximately one-seventh of the weight, *but one-half of the value* of the steel of the whole country; of a university of great resource and reputation, which had grown —it is interesting to note—from the opening, in 1879, the year of the Association's first visit to Sheffield, of Mark Firth's Foundation, Firth College; of a busy and friendly people and, finally, of, not far away, the peace and beauty of moors and dales. It is not difficult to believe that a former Vice-Chancellor of the University once said of Sheffield that it 'reminded him of Florence seen from the surrounding hills'.

The Reception Room, which was located in the Assembly Hall of the Central Technical School, opened for business on the morning of Tuesday, August 28, and soon took on the air of bustling purpose that was to mark it as the main administrative centre of the Meeting for a week to come. Indeed this building, situated in the City Centre and close to the City Hall, the Town Hall, the Cutler's Hall, and the Central Library, proved a most convenient central meeting place for the members. The Sections were accommodated in the University area, mostly

in University buildings; Section L (Education) met in the Blind Institute, Mappin Street, and the Assembly of Corresponding Societies in the City Museum, Western Bank. The whole of the business of the Annual Meeting was thus focussed at two main points: the University and the Reception Centre in Leopold Street.

The convenience of this arrangement was enhanced by the special catering facilities made available to members. The main centre was on the lower floor of the City Hall—only two minutes' walk from the Reception Centre. Here, a large restaurant with both cafeteria and waitress service enabled members to take lunch and other meals close to the Reception Centre and to the main bus station for excursions. Light refreshments were also available in the Students' Union of the University. No mention of the Reception Centre would be complete, however, without reference to the Press Bureau, which was located in the adjacent Bow Street School. Here, in the capable hands of the Press Officer, Mr. Charles Hervey, and his staff, whose services had so generously been put at the Association's disposal by the United Steel Companies Ltd., a continuous and comprehensive service, which can scarcely have been equalled at recent meetings, was provided for all members of the Press.

Members themselves were accommodated in hotels and lodgings in Sheffield. In addition to this the whole of the accommodation in University Halls of residence and in Training Colleges was reserved for their use. Several of these Halls have been built quite recently and are fine examples of collegiate architecture. Some were in former great houses, such as Wentworth Woodhouse, magnificently situated and of great interest as well as substantial comfort. The pleasure which members derived from their accommodation in this way and the greatly increased range of opportunity for friendly intercourse that it made possible was enhanced by the most generous provision by the Local Committee of special bus services, free to members, which not only ran at appropriate times during the day on a circular route linking the University and the Reception Centre with the hostels, but also brought members in to their Meetings from the more distant Halls and took them back after all the evening functions.

Unlike most of the industrial towns of the North, Sheffield is set in glorious countryside. Within a short distance of the city are the wind-swept moors, an unrivalled playground in which all Sheffield rejoices. Nearby are deep dales, great houses—Chatsworth, Haddon, Hardwick—and the little limestone villages of the Peak district. The programme of some 140 general and sectional excursions which was arranged to supplement the formal sessions took advantage, therefore, not only of the industrial scene but also of the manifest beauty of the surrounding countryside. A special bus station, within easy reach of the University and Reception Centre, was brought into use and nearly every excursion started and ended there. The excursions were thoroughly well organised and the hospitality of the many hosts—too many to acknowledge individually—was very widely appreciated by members.

A week—occupied as it is with a full programme of scientific sessions, excursions and evening functions—is far too short a time to allow more than a superficial acquaintance with all that a great city like Sheffield has to offer. Members were further indebted to their hosts, therefore, for the presentation to them of a permanent record of their visit in the form of a superbly produced book containing a scientific and historical survey of Sheffield and its region, produced under the general editorship of Professor D. L. Linton. This volume, extensively illustrated, and beautifully printed by the Oxford University Press, adds magnificently to the post-war series of scientific surveys of the regions of Annual Meetings. In three parts, the first gives an account of what may be termed the history and prehistory of the region; the second treats of the 'City of Sheffield' and deals with aspects of its economic development; with the growth of its social institutions; with

its contributions to art and science and with its present characteristics. The third part, under the heading 'The Region Today' deals with some of the industries by which the inhabitants of the region gain their livelihood and with the towns outside Sheffield in which they live.

The excellent arrangements made for members included a most interesting innovation. This was the issue by the Local Executive Committee of a member's diary the idea of which was conceived and executed in Sheffield. The diary contained useful information in a concise form with regard to the Meeting and to the City, specially prepared plans of the city and a full-page daily diary enabling members to record their engagements in handy form. It became obvious from the comments heard on all sides that members found this diary of great value to them and that the idea was one well worth repeating—if it were possible—in future years.

On the morning of the opening, Wednesday, August 29, the City and the University jointly entertained the President, and other Officers and Overseas Guests of the Association at a reception in the Cutler's Hall. The guests included the representatives of Associations for the Advancement of Science in France, India, South Africa, Ceylon, Australia, Pakistan and America. The City and University then entertained the Officers and certain members of the Association at luncheon in the Town Hall.

The formal business of the opening day was conducted in the afternoon at meetings of the Council and the General Committee. The General Committee met in the Memorial Hall of the City Hall. Professor P. M. S. Blackett, F.R.S., was elected President for 1957 and invitations to hold the 1959 meeting in York and the 1960 meeting in Cardiff were enthusiastically approved. Sir Raymond Priestley, M.C., was presented by Prof. J. K. Robertson with a Presidential Badge to be known as the Toronto Badge. [A Fund was voluntarily subscribed by the Members of the Association from this country who were present at the Toronto Meeting in 1924, and was called 'The Toronto University Presentation Fund'. In 1954 the Council, with the approval of the University of Toronto, decided to expend the Fund on the purchase of a Presidential Badge, to be called 'The Toronto Badge.']

In making this presentation Professor Robertson said:

'The badge fulfils a double purpose. Year after year it will recall the happy association of the B.A. with the University of Toronto. Year after year, it will also provide visible evidence of those strong invisible bonds which unite Canada with what many of us Canadians call "The Old Country".

As a graduate of the University of Toronto and as a Canadian, I feel honoured in having the privilege of presenting you, Mr. President, with the Toronto Badge.'

The General Committee also received and approved an interim report on the functions of the British Association which had been submitted by a Committee under the chairmanship of Sir Ben Lockspeiser, K.C.B., F.R.S. The text of this report is printed on page 205–6 of this issue of the JOURNAL.

The Inaugural Meeting was held on the evening of August 29 in the magnificent Oval Hall of the City Hall. Members of the Association were welcomed to Sheffield by Alderman Robert Neill, the Lord Mayor of Sheffield, in a short speech which was notable for its warm and friendly humour. The Chancellor of the University, the Rt. Hon. the Earl of Halifax, K.G., P.C., O.M., G.C.S.I., G.C.I.E., D.C.L., LL.D., then declared open a Congregation of the University and conferred the degree of Doctor of Laws, *honoris causa*, on Sir Raymond Priestley, M.C., and the degree of Doctor of Science, *honoris causa*, on Sir George Thomson, F.R.S., and Sir Charles Goodeve, O.B.E., F.R.S. The Chancellor then declared the Congregation closed and Sir Raymond Priestley, took the Chair and, having formally opened the Association's 118th Annual Meeting, delivered his Address on 'Twentieth Century Man against Antarctica' (*Advancement of Science*, Vol. XIII,

No. 50, p. 3). At the conclusion of his Address he was thanked by Sir Harold Hartley, K.C.V.O., C.B.E., M.C., F.R.S. in a short speech of great warmth and sincerity.

The outstanding social function of the week was the Reception which was held at the Cutler's Hall on the evening of Thursday, August 30, and to which all members were invited jointly by the City and the University. Members thronged the various fine and dignified rooms in informal concourse and inspected a most interesting series of exhibits which had been arranged for the occasion. The history of the industry of the City of Sheffield—be it noted—is indissolubly bound with that of its ancient company, the Company of Cutlers in Hallamshire in the County of York, founded in 1624. The trade mark 'Sheffield', synonymous throughout the world with quality and craftsmanship is, in fact, the registered property of the Company.

Two evening discourses were arranged and took place in the Oval Hall of the City Hall where audiences composed both of members of the Association and of the general public heard Prof. F. G. Young, F.R.S., speak, on the evening of Friday, August 31, on 'The Growth of Biochemistry' and Prof. Sydney Chapman, F.R.S., speak, on the evening of Monday, September 3, on 'The International Geophysical Year'. Professor Chapman's address will be published in a future issue of *The Advancement of Science*. There were also two public lectures, both of which drew large audiences. Sir Raymond Priestley, M.C., President of the Association, gave the first at 8 p.m. on Thursday, August 30, under the title of 'Antarctic Adventure'. The second was delivered on Tuesday, September 4, at 8 p.m., by Sir John Cockcroft, K.C.B., F.R.S., on 'The future development of atomic energy'.

On Friday, August 31, the President held a reception in the Students' Union of the University for the Student Exhibitioners which was attended by about 100 student members. At this reception he presented cheques to the winners of the Endeavour Essay Competition, the first prize going to Mr. J. M. Vail of the Department of Mathematical Physics, University of Manitoba. Mr. Vail's prize was received in his absence by Prof. J. K. Robertson, a former President of the Royal Society of Canada.

On Tuesday, September 4, the President and other Officers of the Association entertained to dinner, in the magnificent setting of the Old Banqueting Hall of the Cutler's Hall, principal local officers and overseas guests. Mr. P. M. Sherlock, C.B.E. replied most delightfully to the toast to the Overseas Guests.

On Sunday, September 2, at 11 a.m., officers and members of the Association attended divine service in the Cathedral Church of St. Peter and St. Paul—a twelfth-century foundation. Officers of the Association joined representatives of the City and the University in a colourful and impressive procession in the Cathedral. The Right Rev. the Lord Bishop of Sheffield (Dr. Leslie S. Hunter) preached the Sermon, in the course of which he reminded scientists of their moral responsibility to Society and declared that 'A fundamental need of the western quasi-Christian world is a new reformation of thought and belief which would give men once again a coherent world view'. The text of Dr. Hunter's sermon is published on pages 175–177 of this issue of *The Advancement of Science*. The Lessons were read by the Vice-Chancellor of the University and by the President of the Free Church Council.

The same evening over 2,000 members crowded into the City Hall to listen to an orchestral and choral concert arranged for them by their Sheffield hosts. The concert was given by the Hallé Orchestra, which, owing to the indisposition of Sir John Barbirolli, was conducted by Mr. George Weldon. An intent and appreciative audience heard, during the first part of the programme, Brahm's Academic Festival Overture, Opus 80, Wagner's Siegfried Idyll and Schubert's Symphony in C,

No. 9. Mr. Herman Lindars conducted the Hallé Orchestra, the Band of the Royal Air Force Regiment and the Sheffield Philharmonic Chorus during the second half of the programme, which was devoted to a striking presentation of his own work 'Dedication'—specially written for the Sheffield Coronation Concert on June 6, 1953, and intended to be performed once only.

The scientific programme occupied the mornings and in some cases the afternoons of Thursday, Friday, Monday, Tuesday and Wednesday (August 30, 31, September 3, 4 and 5). The meeting as a whole was notable for its distinct emphasis on, first, industrial topics and, secondly, on the theme of Antarctica introduced on the evening of the opening day by the Presidential Address. The Sections received over 300 communications (not counting impromptu contributions to discussions) many of which formed part of a more limited number of major sessions on single themes or of joint sessions between one or more Sections. To quote *The Times*: 'At least one new discovery of importance was announced—the discovery for the first time of a chemical difference between one human being and another, capable of exact specification in the laboratory, and controlled by a single hereditary factor so that the effects of mutation in a single gene are seen.' In other discussions there were new additions to work known already to be in progress; more important to most of those present, useful reviews were provided of advances covering a fair part of science. The following are a few of the topics which were headlined in the national daily Press which, along with *Nature*, *Discovery*, *Engineering*, and other periodicals, reported the Meeting very fully: The Antarctic Challenge; New Light on Taste Cells; Gain and Loss in Television; Prices as a Factor in Transport; Taming Nuclear Power; Oil in the pre-Atomic Age; New Steel-making Processes; Impact of Education on Colonial Peoples; The Unity of Living Things; Food Problems in 2056; Automation; Climatic Fluctuations; The Wisdom of the Body; Science and Arts Courses; England's Drift from the Equator; World Population Growth; Use of Magnetic Materials; Diseases have Their Blood Groups; and Metals Conscripted to Help the Farmer. The Sectional transactions are summarised at the end of this volume, which also contains a report of the proceedings of the Assembly of Corresponding Societies.

The Section dinners, which were well attended, were held on Friday and Monday nights. Members of the Engineering Section were invited to a conversazione at the Department of Applied Science at the University on the Monday evening. The Graves Art Gallery held an open evening on Saturday, September 1, at which the main attractions for members were a special exhibition of pictures, drawings and engravings by Augustus John, a display of bird prints by Audubon and Gould, and a static display of picture restoration. Equipment and materials used were on show, and members of the staff were in attendance to answer questions. The City Museum at Western Bank also held an open evening for members on Saturday, the main feature of which was a special exhibition illustrating the archaeology and natural history of the Sheffield region arranged in collaboration with local societies. Members were also able to inspect the Museum's various collections, which included the Bateman collection of antiquities and unique displays of cutlery and Old Sheffield Plate.

In addition to these special evening functions there were a number of admirably organised and most interesting exhibitions which were open daily and were well attended both by members of the Association and of the public. The most outstanding of these was the 'Science in Schools' Exhibition organised by the Director of Education for Sheffield and the science masters and mistresses throughout the region. The need for more well qualified specialist teachers of science has focussed attention anew on the importance of the work of the schools in laying foundations in the study of science, and the 'Science in Schools' exhibition contributed most significantly and valuably to this end. Notable features of the exhibition

were the working experiments and demonstrations by pupils in attendance, covering a wide range of study, including Physics, Chemistry and Biology, and the special section illustrative of the study of science in secondary modern schools. 'The most remarkable exhibit', according to *The Times Educational Supplement*, 'was in the secondary modern section. It was a microscope made out of old milk bottle tops.' Simultaneously with this exhibition there was a display of Schools' Commonwealth Studies, arranged in conjunction with the Imperial Institute and including studies of Commonwealth interest undertaken by the Sheffield Training Colleges.

There were also a number of other special exhibitions on view. In the Applied Science Department of the University there was an exhibition of Metals at High Temperatures. In the Central Library—a fine modern building distinguished by its gleaming Portland stone—there was an exhibition of Non-Specialist Books, arranged by the National Book League and a scientific and technical display illustrating the service provided for industry by Sheffield's Science and Commerce Library and, finally, a display of various ASLIB publications. In the Central Library members were also able to see important manuscript collections, including the Wentworth Woodhouse Muniments and the Edward Carpenter and Fairbanks collections. In the Department of Chemistry in the University there was an exhibition of glass-making and laboratory glassware, showing some of the manufacturing processes and products of the British Glass Industry. In the Department of Physics there was a small exhibition, entitled 'Science and the Explorer' which displayed ration packs used by explorers and climbers, and other specimens of food and equipment used in Arctic and sub-Arctic areas in both high and low altitudes.

The Scientific Films Committee of the Association again organised daily screenings of appropriate films. The programmes were organised by Mr. Alec Hughes, Secretary of the Scientific Film Association and the films were screened in the Lecture Theatre of the Central Library. The enormous scope of the film today as a medium for scientific information, education and research was more than evident in this series of film programmes. Members were able to see something of the immense problems encountered in combating pest-borne diseases in backward territories, to appreciate some of the complexities of breeding disease-resistant plants, to witness the incredible variety of products made with plastics, to survey the field of crystallography and to study in detail the behaviour of bees at the hive entrance. They saw the past in the archaeological survey of the Polish settlement of Biscupin and saw something of the world before man appeared on its surface in a geological study of the formation of coal. They glimpsed the present in the field of medical research, in the development of physical research in India and in oil exploration in Pakistan. They peered into the future in the automatic chemical laboratory, the world of electronic computers and in the immaculate cleanliness of the first Russian atomic power station.

No record of an outstandingly successful week would be complete, however, without mention of yet another Sheffield 'first'. For all the while that members were engrossed in their social and scientific occasions a team from the University Film Unit was quietly and unobtrusively at work making a photographic record of the meeting as a whole. It is hoped that the results of this most ambitious undertaking will satisfy its sponsors. It is certain that the film, when it is complete, will be of great interest not only to those who were present at Sheffield but to all who come regularly to the Association's annual meetings.

At their final session, on Wednesday, September 5, the General Committee passed with acclamation the following Resolution of thanks to all in the region who had done so much to ensure the success of another great meeting :

At the close of this particularly important and most successful meeting of the British Association in Sheffield, the General Committee resolves to record their sincere appreciation of all that has been done in the City, in the University and throughout the whole

region, to make the meeting one of the happiest and most fruitful within the recollection of those present.

The General Committee desires to express the warmest thanks of the Association to the Lord Mayor of Sheffield, the City Council and their Officers and staff ; to the Master Cutler ; to the Chancellor, the Vice-Chancellor and the staff of the University of Sheffield, and the Students' Representative Council ; to all firms and organisations in this great industrial region who have so freely and generously opened their premises to members of the Association ; to the Chief Constable and all other officers of the Police of Sheffield, for their efficiency and courtesy, and to the kindly citizens of Sheffield for the cordiality and patience with which they have received their guests.

SCIENCE AND INDUSTRIAL INNOVATION[1,2]

by

PROFESSOR B. R. WILLIAMS

ECONOMISTS have written a great deal about innovation—entrepreneurs, who make these innovations, create new processes and new products or improve old ones, by exploiting an invention or an untried technological possibility or by creating new markets or new patterns of organisation.

With the growth of industrial research, however, innovation is now regarded in some firms as a normal, a near-routine function, and not as a creative act of entrepreneurship. Professor Schumpeter, who made a great contribution to our understanding of innovation, wrote of the decay of the entrepreneural function. He argued that technical progress is increasingly becoming the business of teams of trained specialists who turn out what is required and make it work in predictable ways. The romance of earlier business adventure, he wrote, is rapidly wearing away, because so many more things can be strictly calculated that had of old to be visualised in a flash of genius.

In this paper, I will be concerned with the type of innovations he presumably had in mind, namely, those arising from industrial research and development. Later, I will say something about his forecast that innovation would become a routine activity.

To get clear the nature of innovation, we need to distinguish between innovation and invention. An innovation is an invention that has a profitable use in business life. A few illustrations will make this clear. Automatic transfer machines in the motor car industry, and automatic process controls in the chemical industry, are innovations. They work and they are economical. The British Iron and Steel Research Association's new chemical process for making steel is an invention but not an innovation. It has yet to be proved that it can be used, and used with advantage, for the commercial production of steel. When the transfer machine was first invented at Morris Motors in 1923, it did not then go beyond full-scale workshop trial. The ancillary equipment was not reliable. Twenty years later it was, and the invention became an innovation.

When we discuss the application of science to industry, this distinction between invention and innovation is most important. For every one invention or new scientific idea that has application to industry, there are hundreds that have not. And for every one that has immediate or direct application to industry, there are hundreds that must be made ready for use by a very expensive process of industrial research and development.

Industrial research and development is the process whereby new (and old) scientific ideas are consciously used to create new products that will sell, new processes that will be more economical, or new processes that will use a new raw material in place of one that is becoming scarce. (An example of this last is the (civil) research and development programme of the Atomic Energy Authority.) With this industrial research the objectives are very practical and commercial—to produce new things that will pass the test of economical use. In this process hundreds of inventions are thrown away simply because it would not pay to

[1] Paper read to Section F (Economics) of the British Association at Sheffield on September 6, 1956.

[2] This paper is based on an investigation into the application of science to industry financed by a Conditional Aid Grant. A full account of this work is given in a forthcoming book entitled *Industry and Technical Progress* by C. F. Carter and B. R. Williams.

develop them; in other words, our scarce resources of labour and capital can be better employed in other ways.

Any country that does *not* use in industry a high proportion of its scientific ideas or inventions is pretty poor in ideas. A good illustration comes from the Research Corporation of New York—a non-profit organisation which takes out patents for research laboratories and universities. It has found that only 1 per cent of the patents give a big excess of royalty income over patent and development expenses; 9 per cent show a small profit; 20 per cent break even; and 70 per cent are a net loss to the patent owner. The National Research and Development Corporation is likely to find much the same thing. In industrial research and development departments, experience is very similar. Many novel ideas, coming perhaps from basic research in universities, may seem worthy of industrial application. After applied research many of these ideas are dropped because it proves impossible to scale up from laboratory scale without grave complication or because it is clear that the process would be too costly. Two-thirds of these novel ideas may be set aside and one-third sent forward to be developed in a form suitable for production. Many projects fail at this development stage—the new process may turn out to have only a small (or no) cost advantage; the new product may be proven by market research to be unwanted. For every hundred ideas that are judged worthy of industrial research ten or less will be proved worthy of industrial application.

When people talk of slowness in the application of science to industry, it is quite common to hear a sharp distinction made between the scientist and the business man. Such a sharp distinction is very misleading now that industrial research and development has become a technique of business management. It, like costing, budgeting, and production planning, is a technique used by efficient managers. Applied science in other words has become part of the business complex; industrial scientists are business men using their techniques (and the firms' materials and equipment) to produce new products and new processes that will be commercially profitable. More than one-half of British expenditure on research and development is carried out in privately owned business firms.

Industrial research and development is of fairly recent growth, and it has been growing rapidly. In the U.S. expenditure as a proportion of gross national product increased tenfold between 1920 and 1950. In Britain, after a later start, the growth appears to have been even faster. It has certainly been fast enough to produce an acute shortage of scientists and engineers.

The growth in industrial research and development has not affected all industries equally—nor has it affected all firms within an industry equally. The Federation of British Industries survey, *Research and Development in British Industry*, 1950–51, showed a variation between 5 per cent of turnover in scientific instruments and light electrical engineering to 0·4 per cent in food, drink and tobacco and ferrous metals. As percentages employed in research and development the new Department of Scientific and Industrial Research survey of spending on, and employment in, industrial research indicates a variation between 12 per cent in aircraft to less than half of 1 per cent in non-metalliferous mining products; iron and steel; other metal goods; textiles; food, drink and tobacco; wood, cork, paper; building and contracting.

The reasons for such variations are fairly obvious:

(1) Aircraft and mineral oil refining, employing on research and development 12 per cent and 6 per cent of their respective numbers employed, are quite out of line with other industries, of which chemicals with 3 per cent is highest. In aircraft, the major part of research and development is financed by the Ministry of Supply for defence purposes. In mineral oil refining the cost of materials used is over 90 per cent of the selling value. This

reflects the nature of the process—the continuous processing of a fairly uniform product. As such a process is easy to make nearly automatic, manufacturing employment is small.

(2) Some industries are based on science, others are not. We find the greatest attention to research and development where a developed science or technology has a close bearing on the industry's products or processes; for then an advance in the appropriate science is likely to have an immediate effect on the firms in the industry. An advance in organic chemistry is more likely to have an immediate effect on the chemical industry than is an advance in electronics on the machine tool industry.

(3) Where an industry is based on science there will be a vast amount of scientific data in existence that is relevant to industrial activities and there will be, from the normal processes of the higher education, a supply of scientists trained in this field. This brings a great contrast between the profitability of industrial research in, say, pharmaceuticals and pottery.

(4) In some industries where research is not essential to production, firms are too small to afford a research department. Such industries rely on co-operative research or on suppliers for the main improvements in product and process. They may not be backward in applying science when opportunity arises, but they do not create the opportunity—they adopt the development of others.

But what of variations between firms in the same industry? In my experience few firms that conduct research and development have given much thought to the optimum expenditure on it. In other words, although industrial research and development is a management technique, it is doubtful whether the technique is properly used. Now if it is not, the application of science to industry will be neither as fast nor as extensive as it could be. Maybe some important potential lines of innovation are not even thought about. It is worth asking the following types of question:

Is the gap between invention and innovation excessive? Are projects for research properly selected? Are projects taken from development to application rightly chosen? Are some left behind because the expected investment yield is pushed too high? Are some left behind because the organisation of the firms is not adapted to absorb new products and processes?

I will start with the optimum expenditure on research. It is not possible for any firm to say that the optimum rate of expenditure is £x and not £$\cdot 9x$, for research is in some measure unpredictable. There are, however, certain critical factors around which a judgment may be made. Excepting a few very large firms which conduct non-directed research for prestige and for help in recruiting scientists, the objective of industrial research is to create products or processes that the firm can use with profit.

But what can a firm use with profit? The answer to this depends on a knowledge of a number of factors:

(1) Methods of production, the potentialities of change and the kind of change that would bring the greatest reduction in costs or improvement in quality or increase of output.

(2) The market situation—the strength of competition, the possibilities of growth in existing and potential products.

(3) The financial position of the firm—how long the firm can afford to wait for research results, how big a sum the firm could invest in a new product or process, how big a prospective yield it would require.

(4) The capacity of the firm to absorb changes of various kinds.

An examination of these factors enables a reasonable decision to be made about research and development expenditure. The choice of the appropriate scale of research and of the type of projects depends on a close liaison between the various departments and interests involved. After a survey of 150 firms in a variety of industries, I would judge that such close liaison is achieved in considerably less than one-half of firms which conduct research and development. The firms that do not achieve this co-ordination fall into opposite categories—those who underestimate and those who overestimate the contributions of industrial scientists. The former treat scientists as if they are good for nothing except technical testing and salvage; the latter treat scientists as creatures who, if they are given good quarters and expensive playthings, periodically make magic (and profitable new inventions). Effective industrial research however requires the close co-ordination of research, production, and selling activities of the firm; while the capacity of the firm to apply the new method or introduce the new product often requires a close working partnership between production and research, and sometimes a shift of scientists from a research department to a production or service or selling department.

The function of scientists in industrial research is not simply as the new-ideas men of the firm. In a study of the 150 firms mentioned and some 300 actual innovations involving industrial research, the origin of the innovation was found to be outside the research department in 70 per cent of the cases. The research department made these innovations possible, but did not originate them.

Some of you may have seen published statistics on the origin of industrial research projects. Dr. Lodge has shown that in British Nylon Spinners 45 per cent of the topics arose from within the research department, 26 per cent from operating units and 16 per cent from sales staff. Several published American estimates are very similar. I have found this typical of the chemical and related industries, but not of other industries. In 'other industries' the proportion of projects that originate in the research department is smaller. For 300 *actual innovations* involving the research department we have found that less than one-third originated in the research department. These statistics should, however, be treated with reserve for the greater the co-ordination within the firm the more difficult is it to pin the origin of an innovation.

I have brought in this evidence about origins to make it clear that research is not something that can be tacked on to a firm to make it dynamic, as an outboard motor to a boat. It is one of a complex of interrelated functions to be performed in a firm that is concerned with survival, where innovation is part of the competitive struggle, or with a planned increase in profits and assets.

But even if research and development projects are wisely chosen, they lack point unless the successful projects are used. Is there an avoidable impediment to innovation even in firms that conduct their research efficiently? Is there, for example, opposition to the use of the research department's output? Are structures of management quickly adapted to make use of the new technical possibilities? Are investment decisions too cautious?

The conduct of a firm entails the exercise of a number of functions represented by the division between the Board and the management, and by the division of management into functions such as production, sales, finance, control, development, and personnel. Decisions on what to produce and how to produce it must be made, and then executed. The function of execution entails a set of authority relations running from the Managing Director to the foremen or charge-hands. It also of course entails more than a set of authority relations. For various decisions are made at different levels in the authority structure. Some decisions are deliberately left for lower levels of management—particularly details of technique—others are made necessary by unforeseen events or difficulties during the process of execution. Managers, therefore, require technical and social skills to enable them to give

effect to policy decisions and executive directions. The call on technical or technological skills of managers—to enable the formulation of correct decisions about policy and execution—becomes greater as the extent and frequency of innovation increases. In a craft or traditional industry the working craftsman can decide most problems of execution within departments, but as science is applied to industry dependence on functional specialists must increase.

The process of rational decision-making—both at the level of policy and at the level of execution—also becomes increasingly dependent on specialists who perform the functions of investigation and evaluation. (Research and development are aspects of these functions.) In the performance of these functions the dependence on formal organisation is reduced relative to the dependence on the scientific or technical skills of the functionaries. In turn, these functionaries cannot function within a rigid and formal authority structure. Informal or *ad hoc* relations between the people performing the functions of investigation, evaluation, decision taking, and execution, become essential to efficiency. By its very nature the authority structure must often become inappropriate or irrelevant to the process of technical change.

In many cases the use of an invention involves a significant change in the organisation of the firm. Thus it may be necessary to introduce into the firm functional specialists who disrupt the old principles or practices of line management. This disruption may create resistance to change by departmental managers and foremen. To overcome this it may be necessary to think out new lines of responsibility and new spheres of influence; or to change the men who hold particular management positions. All people who have worked in this field could quote cases of resistance to change, or difficulties in carrying through change that results from failures to adapt the organisation and the balance of skills in the firm to the new technical situation.

We have often noticed in our investigations that firms with a good record in applying science to industry—a good record in innovation—give periodical attention to fitness of their organisational structure for the developing technical and marketing problems of the firm. This does not mean of course that firms with poor management arrangements in some particulars cannot innovate. But poor management arrangements hinder innovation and the greater the attention to innovation the greater the probability that the firm will be forced to give very close attention to its management arrangements. We have found a number of cases where firms have in this way been impelled into the use of 'modern' management techniques, including in these techniques efficient training and recruitment arrangements. The management of innovation is many sided.

There are cases of inventions that do not entail capital expenditure: an improved chemical formula may be used in production without extra cost. In most cases, however, an investment decision is involved even when the invention is capital saving. An automatic inspection device making it possible to re-adjust a machine before it has been long wrong may reduce the number of machines needed simply because the machines now turn out less spoilt ware, or the capital cost of an automatic transfer machine may be less than the replaced machine tools. Yet an investment is needed, and is painless, so to speak, only if the old machines were due to be replaced.

How are these investment decisions made? Are our 'financial heads' too timid to produce a proper conversion rate between inventions and innovations? Or is there difficulty in raising capital? Are we as a community creating a low conversion rate between inventions and innovations by not saving enough?

The basis of investment decisions is very difficult to discover. There is, however, no need here to give an account of the difficulties of collecting and above all of interpreting information about investment decisions. Suffice to say that during our

investigation we have not found any evidence that our financial heads must see a prospect of getting their money back in an excessively short space of time before they will invest in a new process or product. By excessive here I mean something shorter than an American or German business man would insist on. They may make more cautious estimates of market prospects—of that I cannot speak, as nobody has yet paid me to investigate American methods of business forecasting!

In any case, since the war, capital re-equipment and the conversion of inventions into innovations have used up all the capital available. Less cautious estimates of market prospects would simply have created a bigger queue of uncompleted projects.

But even if additional capital had been available there would have been a quick limit to further innovation set by the existing supply of draughtsmen, designers, physicists and chemists. Even within the existing capital supply the shortage of engineers and scientists has restricted the innovation activities of most firms that undertake research and development. This restriction has operated at both the research stage and the development stage; though due to the acute shortage of draughtsmen and engineers, the latter has been most affected.

The critical factor here is not inadequate saving but an inadequate system of education. In particular our output (per head of population) of technologists is very small, compared to that of the U.S., Germany and Switzerland

So far I have spoken of firms that conduct research and development. Many firms do not. Some firms do not need to conduct research or to perform a specialised development function, but simply adopt ideas or developments of suppliers or research associations. Others are, given the nature of their product, too small to finance research and development. In both these cases efforts may be made to keep abreast of relevant scientific and technological developments—efforts which necessitate attention to the functions of investigation and evaluation. Where, because of ignorance or indolence these functions are largely ignored, the firms become parochial and unprogressive. In this parochial and unprogressive class we may also find firms that could profit from, and are large enough to finance, their own research and development.

We should remember of course that if there were no parochial firms the shortage of scientists and technologists would be considerably increased. Here this fact simply emphasises the significance of the problem that innovation in progressive firms is dependent on the actions of parochial and adoptive firms.

This dependence is a two-fold one:

(i) A firm that has invented a new product that is intended for process use in other firms will not turn the invention into an innovation unless it expects these other firms to buy it. Innovation in creative firms in other words depends on receptivity in other firms.

(ii) An innovation, whether a product or a process, will often necessitate the purchase of a new type of machine or material. Unless the appropriate firms are prepared to make this new type of machine or material the innovation will not be possible. Sometimes this new machine or material will require a research or development effort on the part of the supplying firm. Unless such a firm is capable of, and interested in, this development effort the potential innovation will be frustrated.

This frustration may of course affect a whole industry. Thus in the cutlery industry, according to the Working Party Report, a few progressive firms were unable to get machine suppliers to develop a new machine for the industry because the supplier did not expect that other firms would be prepared to adopt it. Research Associations can help to overcome the deadening effect of parochial and unprogressive firms by undertaking the development. This, however, is not the

complete answer as a Research Association cannot perform all the development work unless it itself undertakes the manufacture. The National Research and Development Corporation has power not only to give development contracts to firms but also to place preliminary production orders, but even this power cannot overcome the retarding effect of parochial firms.

Innovation then depends on the appropriate chain of relations between firms. This chain of relations in Britain is such that we are nowhere near that stage of development predicted by Schumpeter, where innovation is the business of teams of trained specialists who turn out what is required and make it work in predictable ways.

Effective research and development requires close co-ordination between the research, production and sales departments within firms. In turn the use of an invention often requires a change in organisation, the creation of new posts, or a change in the persons holding particular posts. These problems of adjustment are never likely to be easy. In addition, the use of an invention quite frequently depends on creative or adoptive action on the part of outside firms. If the relevant outside firms are not creative or adoptive the gap between the invention and the innovation is not bridged.

The growth of industrial research has speeded up the process of change: it has not made it automatic; indeed it has forced business men to face very difficult problems of human adjustment, the solution of which is not likely always to be smooth or easy. Nor for that matter are we ever likely not to need the exceptional few who can break out of the conventional framework of thought to create new scientific and industrial possibilities.

THE LOCAL SOCIETY IN THE COMMUNITY OF TODAY

ADDRESS BY DR. F. J. NORTH, O.B.E.

PRESIDENT OF THE ASSEMBLY OF CORRESPONDING SOCIETIES

The Problem

The decline in membership and attendance at meetings, to which their reports refer with increasing concern, suggests that local societies are a waning influence in the community of today.

Is this really the case? If so, is the decline temporary or indicative of a permanent trend, and what can be done to arrest it? The Assembly of Delegates from Corresponding Societies is an appropriate occasion for asking and seeking answers for questions like these.

The invitation by the Council of the Association to preside at this year's Assembly is an honour that I greatly appreciate and will do my best to justify. That much I owe, not only to the Council which extended the invitation, but to you who have endorsed it by your presence this afternoon. I will try to discharge my debt by evoking discussion on the questions that confront us, for that will, I think, be more profitable than attempting to place before you ideal plans for enabling our societies to enter upon a new phase of expansion in membership and activity, and a new era of appreciation by the public at large.

That is what we want, and what those who founded the Conference of Corresponding Societies nearly seventy years ago had in mind; but whilst it should not be difficult to suggest measures which, if they could be put into effect, would fill our lecture-rooms, improve and ensure the regular appearance of our transactions, and increase our prestige beyond all expectations, the operative word is 'if', and ifs display an awkward tendency to be associated with buts.

In the circumstances I deemed it advisable to act upon the principle that Shakespeare had in mind when he made Bardolph say: 'When we mean to build, we first survey the plot, then draw the model.'

Looking at the matter with a geological eye, which in a geologist, I hope, is understandable, surveying the plot means considering the history of the rocks involved as a preliminary to understanding their present nature and arrangement, and such understanding is necessary before advantage can be taken of the materials or the facilities which the rocks have to offer, or steps taken to deal with difficulties that are likely to arise because of them.

In other words, in order to go forward purposefully and with assurance, it is necessary to look backwards with care and comprehension, just as in land surveying accuracy in advance can only be attained by the frequent taking of back-sights.

This is not a new idea. It was the guiding principle behind the establishment of the Royal Institution, which has done so much for the advancement of science through research, popular exposition, and social entertainment. Its founder, Benjamin Thompson, was second to none in his desire and his capacity to improve upon existing conditions, and, he wrote, 'In efforts to improve it is always desirable to know exactly what progress has been made, to be able to measure the distance we have laid behind us in our advances, and also that which still remains between us and the object in view.'

We cannot do better than take his advice. We want to advance. Let us therefore get a clear understanding of the object in view, and survey what has been done towards achieving it before considering plans for the future.

The Object in View

This can be expressed in very few words—the advancement of science; but it is an object with many facets. Some of them were outlined in a letter which David Brewster wrote to John Phillips, secretary of the Yorkshire Philosophical Society, in 1831, containing proposals which led to the foundation of the British Association later in the year.

'The principal objects of the Society', Brewster wrote, 'should be to make the cultivators of science acquainted with each other, to stimulate one another to new exertions, to bring the objects of science more before the public eye, and to take measures for advancing its interests and accelerating its progress.'

These are the objects for which local societies existed, but Brewster proposed a yearly gathering where those interested in the furtherance of such objects could meet to exchange views. He did not, however, mention one object that was much in the minds of those who had already founded local societies, namely, the establishment of a museum.

The Yorkshire Philosophical Society itself owed its existence to the realisation that a museum was needed in the city. The interest created by the exploration of Kirkdale Cave in 1821, with its evidences of occupation by antediluvian animals, and a suggestion that the finds should be divided between three local gentlemen, prompted the Rev. W. V. Harcourt to propose that the collection should be kept intact as the nucleus of a museum. The proposal found favour, and the Yorkshire Philosophical Society came into being.

This is but one example of many, and they extend over the whole period during which local societies have been founded. The most recent is the Brecknock Society, founded in 1926, the efforts of which have been so successful that its musuem, established in a disused chapel, is already about to become the county museum. I am sorry that lack of time prevents me from enlarging upon this interesting and important aspect of local society activities, and it must suffice to say that in nearly every instance the association has been of mutual advantage; but if the present trend is continued and nothing done to counteract the influences to which it is due, it may well be that the museums will survive whilst the societies that gave them birth will become things of the past.

The objects of local societies were further defined when a committee of the British Association was appointed in 1883 'to suggest methods of more systematic observation and plans of operation for local societies, together with a more uniform mode of publication of the results of their work'.

The recommendations of this committee resulted in the Conference of Delegates of Corresponding Societies, and the rules provided that 'Any Society is eligible to be placed on the List of Corresponding Societies . . . which undertakes local scientific investigation and publishes notices of the results'. Original work and publication were then regarded as more important than exposition.

It was recognised that many of the societies in large towns, though of high scientific rank, were less favourably situated for field observations than many smaller societies, the existence of which was not generally known. Because of this the committee suggested that the larger societies should enter into friendly relations with those which were smaller and isolated.

To recapitulate: local societies were founded in order to advance the interests of science and to accelerate its progress. The means it was proposed to adopt include the undertaking of local investigations, the publication of records, the establishment and maintenance of museums and scientific libraries, the arrangement of lectures with a view to promoting the diffusion of scientific knowledge, the encouragement of social intercourse and exchange of views between those interested in the objects for which the societies exist, and co-operation between societies, especially when it would enable large ones to help their smaller relations.

This summary of our aims and intentions should, I think, enable us to consider how, under conditions so different from those which obtained when many of them were founded, local societies can continue to exist as progressive elements in the cultural life of today. It will, I hope, provoke discussion at our session on Monday and elicit advice that is based upon experience, for this address is not an *ex cathedra* diagnosis and prescription, but rather, like the coconut at the fair, intended to be aimed at—and the brisker the business the greater the profit.

Changing Conditions

In comparing the activities and status of local societies in Brewster's time with their position today, we have to consider the great difference between the social and economic conditions of the two eras. The early part of the nineteenth century saw the growth of prosperous land-owning, manufacturing and agricultural classes, so that whilst the masses were poor and for the most part illiterate, there was an increasing number of well-to-do people with time to take an interest in cultural matters and means to cultivate that interest. It was from amongst these that the founders of the local societies were drawn.

They were not only people of means but they had enjoyed the privilege of the best educational facilities available at the time—and though the best may not have been very good judged by modern standards, science, as we now think of it, was in its infancy, so that it was possible for an educated person to take an intelligent interest in almost any topic that might be discussed in the meetings of his local society.

Generally speaking, the rest of the population lacked both the background and the time to interest itself in cultural matters, though an awakening realisation that even the manual worker could not live a full life by bread alone had led to the establishment of Mechanics' Institutes in many industrial towns. With few exceptions, however, it was not long before the mechanics were replaced by people like manufacturers, clerks and shopkeepers, and the institutes became places of recreation rather than education.

The spread of educational facilities should have changed all this, and it is not altogether to the credit of local societies that, even today, their members are still drawn mainly from the black-coated workers. Without suggesting that they are guilty of intentional intellectual snobbishness, it cannot be denied that local societies have been less energetic than they might have been in their efforts to draw upon the vast reservoir of potential members that lie outside the professional and administrative classes in the community of today.

Contemporary records and correspondence, which, unfortunately, there is not time to read on this occasion, show that the early local societies, like the scientific subjects in which their members were interested, enjoyed one great advantage that is denied to both today—the exuberance of youth. Announcements of new discoveries were made with enthusiasm and received with excitement; but our generation has grown so accustomed to wonderful innovations that we have almost lost the capacity to wonder. The future of our societies will in large measure depend upon the extent to which they are able to re-create that capacity in their own members and start a sort of chain-reaction in their own neighbourhood.

It is encouraging to realise that even the early societies were not without their critics. *The Leeds Monthly Magazine*, founded in 1829 to diffuse a more active literary spirit amongst the local citizens, soon began to attack the Philosophical Society. Referring to 'the empty verbosity which distinguishes its meetings and the perfect uselessness of all its proceedings', the writer of the article generously declared his intention 'to refrain from noticing the plagarised papers which are weekly read before it, and the pure unadulterated nonsense which floats through the leaden atmosphere of its hall from the mouth of its dilettante members'.

Whether it was because the criticism had been made, or because the state of the Society was such that it was justified, it would perhaps be better not to inquire, but it is significant that the membership fell sharply immediately afterwards. It is a reminder from the past that local societies cannot afford to give their platforms to lecturers who, although well meaning, are unable to express themselves clearly, convincingly, and audibly. It is also a reminder of the importance of cultivating good relations with the press.

Another factor contributing to the demand for and successful conduct of the early local societies was the almost complete absence of organised courses of instruction in scientific subjects. In such circumstances, when those interested in scientific subjects learned by reading and observation, there was no better way of extending their knowledge upon sound lines than by exchanging views with kindred spirits.

Even the specialist was so little ahead of his fellows that discussion was uninhibited. Weak arguments were soon detected and unsound hypotheses demolished, with the result that most of the real progress during the first few decades of the era of modern science was made through the medium of the national and local societies. The *advancement* of science has now largely passed to the universities, colleges of technology, and research institutes, and with an ever-increasing gap between the forefront of knowledge and the comprehension of the ordinary person the need for adequate liaison is greater than ever before.

The Present

Our assessment of the actual and potential position of local societies in the community of today can be made in the light of this brief review of their purpose and the circumstances in which they were founded. We can see how they have been affected by deteriorating and improving conditions, and ask how they can, in the future, escape the effects of the former and turn the latter to their own advantage.

Amongst the conditions which have become more favourable is the extension of educational facilities to all classes. This, in theory, should have greatly increased the body of people from amongst whom new members may be expected to come.

There is now a much greater range of 'visual aids' to lectures and demonstrations, and in some places there are more comfortable lecture-rooms, though all too often the members still have to sit in the severely scholastic atmosphere that was regarded as appropriate in days when the enjoyment of an intellectual feast was considered to outweigh considerations of physical comfort. This, at a time when competing agencies offer such comfortable accommodation, brings us into the realm of unfavourable influences, many of which tend to cancel out the advantages accruing from those we have mentioned. Here are a few.

Whilst towns and urban districts have increased in population, they have also grown in size, and what were once residential areas are now the commercial and administrative town-centres. Since the local society's meeting-place, chosen when the town was small, is usually located in a more or less central position, much of the potential membership now lives too far away for the increased number to benefit the society.

The larger the city or town the more adverse the effect of this areal spread, so that in theory the population increase should have proved advantageous to towns still small enough for people to be living within a mile or so of the local society's meeting-place. It will be interesting to learn in our Monday discussion whether this is indeed the case.

With the passage of time science has become an aggregate of subjects tending to draw farther and farther apart and to surround themselves with conceptions and a language intelligible only to those who make a special study of them. Each branch of each subject is becoming so highly specialised that it is increasingly difficult for

the student of one to be interested in what is being done in another, and well-nigh impossible for the layman to comprehend the work of any specialist at all.

The leisured amateur that laid the foundations of our local societies is no longer with us, and those who have a natural leaning towards some aspect of biology, for example, or geology, feel that there is nothing they can contribute, and therefore no object in joining a society that exists for the furtherance of those subjects.

In many societies an attempt has been made to overcome this difficulty by the creation of Sections, each one covering a limited field of the parent society's activities and catering for a small group of people who, having special interest in or knowledge of the subject concerned, are able to engage in profitable discussion at meetings. Practical work is done by the Sections, whilst the parent society arranges lectures of general interest to a wide range of non-specialist members. This, however, involves a greatly increased number of meetings with an understandable decline in the attendance at any one.

What is undoubtedly the most serious of the deleterious influences is the ever-increasing competition from mass-produced entertainment—especially sound broadcasting and television. There are, as we shall see, reasons for supposing that the effect of the cinema is less than might have been expected. There has also been increased competition from other directions—from the cultural and professional organisations and evening educational facilities which attract the kind of people from amongst whom local societies would like to draw their members.

Cause and Effect

In order to deal purposefully with the effects of these influences we must know something about their relative importance, and I will ask you to consider them in the light of the history of one society—the Cardiff Naturalists' Society—chosen because it is one with which I am familiar and is typical of those in a town large enough to have been affected by most of the relevant changes. The conclusions we can draw will, I hope, suggest comparison with other societies of which the history and determining factors have been similar, or contrast with yet others in which they have been so dissimilar as to challenge the validity of our inferences.

Figure 1 is a graph which illustrates changes in the Society's membership. It records a fairly rapid initial increase, followed by increase at a slower rate until 1914, when the outbreak of World War I introduced abnormal conditions. After that the membership rose very steeply for about four years and then declined until, when World War II broke out, it had returned almost exactly to its 1918 level. Recovery after this war was slight, slow, and short-lived, and 1950 saw the beginning of a new decline resulting in a membership lower than that of more than fifty years ago.

There is nothing surprising in the general trend of these changes but it will be instructive to examine them in detail. After a good start a decline beginning in 1870 resulted in the loss of about 30 per cent. of the members in two years. Such a loss suggests more than normal periodic variation, and specific causes are revealed in the contemporary reports. In 1870 there was an Exhibition of Fine Arts which made such demands upon the most active members that the affairs of the Society were neglected. The situation was made worse by the fact, probably resulting from preoccupation with the big exhibition, that 'a person employed by the late Honorary Secretary to collect subscriptions had absconded with the money'. At this early stage it became apparent that competition could adversely affect the prosperity of a society and that success depended upon efficient management.

The rise after 1872 illustrates the value of attracting public attention. It was in large measure due to a 'very successful conversazione, inaugurated by the President's Soirée and continued during the succeeding week'. The town hall assembly-room 'was crowded daily by a large and fashionable assemblage who

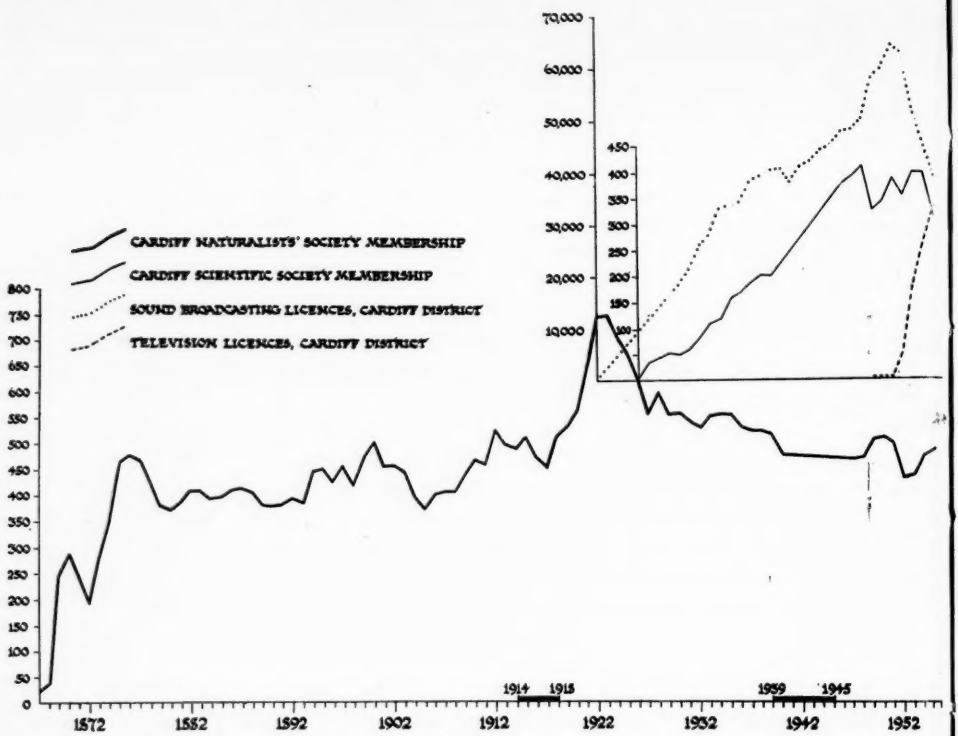

Figure 1

inspected the choice collection of curiosities and antiquities kindly lent by members and others'.

A comparatively small drop commencing in 1879 was attributed to trade depression, but it may have been partly due to the fact that in that year the subscription was increased. This, in itself, is not likely to have discouraged membership, for the amount involved was only half a crown, but the psychological effect of raising subscriptions at such a time is bound to have been inimical. If subscriptions must be increased, would it not be better to act during periods of prosperity and rising membership?

The effects of the depression seem to have been carried over in a reluctance on the part of members to pay their subscriptions, and in 1884 a number of names were removed from the list from this cause. The announcement was made with becoming delicacy in the annual report, which records that 'The Committee decided that it would be best to put more strongly in force a rule whereby members neglecting to perform certain specified duties towards the Society should cease to be entitled to the privileges of membership'.

The neglectful member is, unfortunately, still with us. The recent report of an important metropolitan society had to complain that over 20 per cent of its members were in arrear. It is difficult enough to cope with adverse conditions over which we have no control without creating more of them internally.

Another fall in membership between 1888 and 1893 was attributed to the establishment of several new cultural societies in the town—the ogre or counter-attraction was beginning to raise its head. The lowest figure for this period was reached in 1891, the year that the British Association met in Cardiff. It would perhaps be uncharitable to see a cause-and-effect relation in this situation, but it was not until the third year afterwards that conditions really began to improve!

The outbreak of war in 1914 brought an era to a close for much else than local

societies, and before looking to the new era that commenced when the war ended it will be profitable to see what can be learnt from our review of the Society's ups and downs during nearly fifty years.

After the membership had got into its stride there was a steady slight increase, but it did not keep pace with the increase in the local population. During the period at present under review the membership increased by about 40 per cent and the population by over 120 per cent. The failure to keep in step with the rising population is not surprising, having regard to the increasing competition from other claims on leisure time, and the increasing area over which the people were spread.

It is apparent that the Society was very sensitive to changes in local conditions, and we have a sufficiently clear idea of the causes to which these changes were due to enable us to assess their relative importance in affecting the prosperity of the Society when the new era began in 1918.

The high peak reached in 1922 was the result of the temporary prosperity that often follows a great upheaval like a war. That there would be a decline when the special conditions no longer obtained was inevitable. Of normal causes for the decline the principal one was the changing status of the principal local industry—the export of coal. In the twelve years following 1923 exports from South Wales fell by 40 per cent, whilst unemployment increased 140 per cent. In circumstances like these there was an understandable reluctance to renew subscriptions or to undertake new responsibilities.

This time there was no general recovery as there had been after earlier periods of depression. The adverse conditions were increasing in number and effectiveness, but, strangely enough, competition from cinemas does not seem to have been as serious as is generally supposed. Since 1922 the membership of the Society has gone down by 36 per cent, but the number of cinemas has not changed, so that for the period concerned the decline cannot be attributed to an increasing volume of competition from that source.

Of greater importance is the increase in the number of professional and cultural organisations. There are now more than thirty in the City, and they include amongst their members many who might be expected to be actively interested in the Naturalists' Society if they had fewer claims upon their time.

The decline was suddenly reversed in 1927, and when it was resumed again after about two years it proceeded at a much slower rate until a fresh set of adverse conditions supervened in 1939. Two causes contributed to diminish the rate of decline. One was the celebration of the Society's diamond jubilee, which (like the soirée and conversazione in 1872) was made an important public occasion. Its functions extended over three days. Unfortunately, such celebrations can only be held at widely spaced intervals, but their value is beyond doubt.

The second and most powerful of the contributing causes was the official opening of the National Museum of Wales. There had always been close connexion between the Society and museums in the city, and the Society had played an important part in the campaign for a National Museum. It was, therefore, only right that, through the stimulus which the Museum gave to interest in the subjects for which the Cardiff Naturalists' Society stood, it should have made important and lasting contributions to the Society's welfare. It would not be unfair to claim that it was association with the Museum and the services rendered by its staff that enabled the Society to survive the impact of the increasingly difficult conditions.

The sudden fall in membership in 1929 and the temporary improvement that began in 1932 further illustrate sensitiveness to local conditions. In 1929 the place of meeting was, from necessity, changed. The only available hall was less conveniently situated than the old one and was not liked for other reasons by many members. In 1932 the specially comfortable lecture hall in the National Museum of Wales became available, but the recovery was not as great as was hoped, partly

no doubt because this hall, too, was inconveniently far from most of the public transport services.

As we have seen, the inevitable decline after the phenomenal post-war improvement took place much more rapidly than might have been expected if no more than the causes we have already considered were involved. A new cause, of sudden appearance, was the introduction of sound broadcasting. The decline in membership after the transmitting station in Cardiff was opened was inversely related to the increase in the number of local licenses. It continued so until the second world war made it necessary to suspend normal activities.

The membership began to rise again after the end of the war as it did after the previous war, but before long a new and formidable competitor entered the field—television. At first its effect was small, but when the local station was opened the membership fell by 13 per cent in a single year. It might then have seemed to be a not unreasonable inference that, unless the new conditions could be used to advantage, the Society would soon return to its size of eight years ago, in spite of a five-fold increase in population.

Stated in more general terms, it would seem to have become evident that broadcasting and television, especially the latter, are necessarily inimical to local societies and will still further reduce their chances of survival.

That view has gained acceptance in many quarters, but it should not be accepted without examination. It does not follow that a sudden change of trend coinciding with the impact of a conspicuous new condition means that movement in the new direction will necessarily continue at the same rate or that other conditions are not involved as well.

In the example we have chosen as our factual basis there is evidence that the decline in membership since the end of the first world war is partly due to the changing focus of the layman's interest in science. Notwithstanding the popularity of bird-watching, there has been in recent years a swing of popular interest away from natural history in the direction of archaeology on the one hand and the physical sciences on the other. The former, which has been in large measure stimulated by the B.B.C., could be made to operate to the advantage of societies which include archaeology within their sphere of interest, whilst the latter has been influenced by the increasing emphasis in schools and universities upon subjects and careers that have special importance in a technological and atomic age.

A result of this change of focus is shown by the effect upon the Cardiff Naturalists' Society of a new society with a wider sphere of interest which came into being just as sound broadcasting was becoming popular. In 1926, when the older society was losing ground rapidly, a Cardiff Scientific Society was founded, with the object of stimulating the interest of the public in scientific matters—an object not remarkably different from that of the existing Naturalists' Society.

The membership of the new society increased more rapidly than that of the old one decreased, and by 1948 the total membership of the two together was approximately what the membership of the older society might have been, had the pre-1914 rate of increase been maintained.

The Scientific Society was obviously appealing to a public that the older one had failed to attract. Its success indicated that there was still a considerable corpus of local interest in scientific matters; but was it an interest that would only rise to a small subscription for the privilege of attending lectures and not to a larger one that paid also for an annual volume of Transactions, or was some other factor involved?

The range and status of those who addressed the Cardiff Scientific Society were comparable with those of the persons who lectured at the members' meetings of the older society, so that the prosperity of the former could not be attributed to better lecturers. The difference lay in the ground that was covered. The lectures to the older society related mainly to the natural sciences, archaeology, and travel,

but its younger rival covered the whole range of science and its application to the ordinary affairs of life and to industry, and this wider field included much that was of topical interest.

The Future

We have looked back over our objects and progress in order that we might plan more effectively for the future, and we are, I think, in a position to consider the directions in which action might be taken. The few that I have either the time to mention or the competence to enlarge upon will leave plenty of gaps for others to fill at our discussion on Monday.

Oral broadcasting left local societies with the advantage that their lectures could be illustrated, but television has changed all that, and as most lectures are held in winter months it is not surprising if people prefer seeing an occasional scientific programme at home to regular attendance at meetings of a local society.

It is true that certain televised programmes relate to matters of interest to local societies but there is no evidence that benefits have automatically followed. Archaeology has been specially favoured in this respect, but it has yet to be seen whether the newly created interest is in the subject or in the personalities concerned. When televised archaeological programmes began, the membership of the Archaeological Section of the Cardiff Naturalists' Society went up by nearly 30 per cent, but this was indicative of curiosity without enthusiasm because the average attendances at meetings since that date has only been about 7 per cent greater than during a corresponding number of years before television began.

It was only natural that the novelty of television should have proved almost irresistible for a time, and equally natural that in due course the more serious viewers would become increasingly selective. Evidence that this is more than wishful thinking is shown by a slight upward trend in the membership of the Cardiff Naturalists' Society during the last two years. It does not require intensive statistical research to discover that the confirmed 'TV addicts' are not the kind of people that have supported local societies in the past, or that under existing conditions are likely to do so in the future.

In these circumstances television should not be accepted as a knock-out blow, but as a challenge to be met by action designed to profit from the curiosity and interest its programmes create. It has come to stay, and though the task may not be an easy one, common sense demands that we should consider how it may be made both complementary and supplementary to the activities of our societies—widening the interests of their present members and taking advantage of the new interests aroused in members yet to be.

Adaptation to the new conditions may call for a revision of our programme policy—for plans to ensure that our lecture topics are more closely related to those in which the public are interested than to the personal inclinations of our committees. Would it, for example, be out of the question for appropriate television programmes to be viewed and then discussed, either by members at large or by a small panel of knowledgeable members?

In these days of specialisation there is less opportunity for the amateur than there used to be, except in a limited number of fields in which local societies have always rendered good service—the keeping of records relating to such things as plants, birds, insects, and the weather. This is not because the amateur is any less able; it is largely because he has not the facilities that modern research demands, but, as Sir Richard Gregory said on an occasion similar to this more than thirty years ago, it is not by discoveries alone and the records of them in volumes of Transactions that science is advanced, but by the diffusion of knowledge and the direction of men's minds and actions through it. This, clearly, is where the local society can find its main future task.

There *is* contemporary interest in science and a desire to know what scientists are doing. Well-meaning though sometimes ill-informed writers who are not themselves scientists try to meet the need, though, from failure to distinguish between science and sensation, not always with very great success. Local societies could do a great deal towards fostering the desire for knowledge and ensuring that it is presented in the right way. Presenting in the right way calls for much effort because abstruse concepts and complicated facts are often difficult to express in language with which the layman is familiar. But the effort is not only worth while, it is one of the conditions of survival.

Specialisation involves a special terminology—jargon to those who make no effort to understand it. The supposed inability of the average scientist to express himself intelligibly seems now to have taken its place with the stock jokes about civil servants and their cups of tea, but though they may not all have the command of language that could be desired, their writings, apart from the technical terms, are no more obscure or devoid of meaning than much that is written in journals devoted to art, for example, and they do not, like the economist and those whose wise remarks are recorded in *Hansard*, speak of 'exceeding' the target, or creating 'world-wide' bottlenecks!

Since we communicate with the public by lectures and printed Transactions, it is these to which careful and critical attention must be given. It is often urged that, in order to maintain interest, lectures by outstandingly important people are necessary, but on that there is room for difference of opinion. It would be interesting to pool experience and to discover whether and to what extent this kind of expense brings profitable returns. My own observations suggest that, on the whole, the effect of 'star' lecturers is to increase the attendance at the lecture in question, but not to attract new members. It may well be that money which is available for lectures would be better spent on visits by lecturing members of one society to the meetings of another, or else upon publication.

One of the most valuable and certainly the most lasting of the services which local societies have rendered to the community is the publication of Transactions and Proceedings, but here also adaptation to present-day conditions may be necessary if the service is to be maintained at a useful level.

The drastic reduction in publication enforced by the increased cost of printing can have beneficial effects in that it involves more careful selection by editors and more concise writing by authors, but savings from these causes are far from sufficient to bridge the gap between what should and what can be published, for since 1914 the cost of printing has increased by more than five and a half times.

The issue of Transactions is also affected in another way. Economic considerations are now such that many research workers find it necessary to get their results published quickly. Publication through a local society often involves long delay and the paper is taken elsewhere.

In view of the increasing tempo of life it looks as though local societies would do well to explore the possibility of publication at shorter intervals, and of encouraging, to a greater extent than now obtains, the preparation of brief notices on matters of current local interest so that the Transactions will have a more lively and topical appeal. This is not to suggest that they should degenerate into a sort of scientific *Tit-Bits*, but that they should be brought more closely into line with modern tendencies, where that has not already been done.

The committee which brought our conference into being attached importance to the cultivation of friendly relations between societies, and in present conditions this would seem to be more necessary than at any time in the past. It is a matter about which we would like to hear more on Monday. The South-Western Naturalists' Union, for example, aims at co-ordinating the work of over twenty societies. It acts as a clearing-house for information on matters such as available lecturers,

and enables the societies to speak with a corporate voice on questions like those relating to the preservation of wild life in regions threatened with development. The South-Eastern Union of Scientific Societies, the motto of which is 'Co-operation, not uniformity', serves a similar purpose for over seventy societies in the south-eastern counties.

Recruitment

Whatever we may do to retain present interest in our societies, their future will depend upon the recruitment of members from amongst those who, now of school age, will be the adults of another decade. It is not only necessary to stop leakage, but even more necessary to take steps to ensure an adequate intake.

One factor operating to this end is the service rendered to schools by museums, and this is greater than many people suppose. In the National Museum of Wales, for example, a staff of fifteen, with the active support and guidance of the Director and the departmental staff, is solely concerned with school activities. These include visits to schools, the reception of pupils in the museum, the provision of study facilities for senior pupils, and especially the preparation of material for loan to schools. At any one time the distributed material will include more than two thousand items, including miniature museum exhibits and sets of specimens and photographs that can be handled.

Being organised by a museum, the service is able to emphasise the inspirational interest of the subjects dealt with, as well as provide assistance to those who are preparing for examinations. It was hoped in this way to create, during schooldays, an interest that will remain in after-life, and there is ample evidence that this hope is being fulfilled.

Many other museums engage in school services on varying scales but with similar objects in view. The movement is spreading, and it would be a pity if local societies did not go out of their way to cultivate closer relations than may now exist with museums on the one hand and schools on the other, with a view to taking advantage of this new reservoir of potential members.

The problem of tapping this reservoir is not an easy one. In 1921 the Cardiff Naturalists' Society established a Junior Section with a view to interesting the children of members and their friends in the Society's activities and encouraging them in due course to become adult members.

The venture was successful, but following the common trend the membership of the Section is now considerably less than it was at first. This is partly due to the counter-attractions that have affected all similar societies, but largely to the increasing claims of grammar and secondary school education upon the time of senior pupils. Where there is interest in science and local history it is often catered for by school clubs and there is neither time nor thought to be spared for other organisations. This means, and the same applies to those whose interest is aroused by museum activities, that many desirable members may be permanently lost because, when they leave school, the serious pupils are still fully occupied, whether they go to a university, or to work and attend evening classes, whilst the remainder regard leisure as for amusement only.

This does not mean that junior activities are futile; instead, it points to the necessity for action with a view to reminding young people of the existence of their local society and of the advantages of being associated with it, even at a time when active participation might not be possible. To speak of action to this end is not merely wishful thinking about the unattainable. School clubs arrange lectures and demonstrations and most of them are glad to have visits from outside speakers. What better source of supply for such speakers than the local society, and what better opportunity for a recruiting campaign than a visit to a group of young enthusiasts?

Taking a post often means leaving home, but this does not remove local responsibility. With good liaison potential members could be introduced in their new surroundings to people with interests similar to their own, and our societies as a whole would benefit.

There is much else that could be said, if time permitted and your patience were unlimited, but it would all lead to the same conclusion, namely, that without an adequate intake of members from amongst those who are now adolescent our societies will join the crinoline and the hansom cab as obsolete relics of a more leisurely age. The prospect is obvious enough, but what to do about it is not so easy to decide. Our survey of rise and decline suggests that in approaching the problem we have three cardinal facts to bear in mind. The first is that the community of today would be vastly poorer if local societies were crowded out of existence. The second is that the survival of local societies will depend upon their capacity to adapt themselves to new conditions. The third is the philosophy of life for an increasing proportion of our contemporaries, namely, that it is more blessed to receive than to give.

I have drawn attention to as many relevant matters as my time allows, and have suggested inferences about which there may well be differences of opinion that will provide a basis for a discussion to show us the way we should go.[1]

[1] Address delivered on August 30, 1956, at the Sheffield Meeting of the British Association.

KNOWLEDGE AND LIFE

THE SERMON PREACHED IN SHEFFIELD CATHEDRAL ON SUNDAY, SEPTEMBER 2, 1956

by

THE RIGHT REVEREND LESLIE S. HUNTER, D.D., D.C.L., LL.D.
BISHOP OF SHEFFIELD

Give me understanding and I shall live. Ps. cxix. 144.
This do, and thou shalt live. Luke x. 28.

THESE sentences, if I may lift them out of their context—for my time is very limited—reflect two complementary responses to the world and the demands of life—each incomplete without the other; each an act of faith.

'*Give me understanding and I shall live*' reflects the faith which has inspired and sustained men in the pursuit of knowledge and in successful investigation. If the human mind were not capable of understanding the universe in some measure and of making some sense out of our experience of life; if the universe were chaotic, irrational, with no trace of law and order, there would have been, there could be no science worthy of the name. Faith in the understanding, and in the understandable-*ness* of the world in which our lives are set is the very air that it must breathe in order to live and grow.

I agree with the professor of mathematics who said, 'Science holds within it the stuff of religious experience', and again 'It is one aspect of God's presence, and scientists, therefore, are part of the company of His heralds'.[1] The pietist who fails to see this is allowing himself to be misled by the modest garments of agnosticism in which the seeker after truth often drapes his faith, sometimes hiding it even from himself.

The method of observation, testing and comparison, common alike to all enquirers from the growing babe upwards, has, since the beginning of modern science in the matrix of Christian culture, been transforming human life, altering its pattern and texture. It has reduced mortality and increased longevity. It has enriched the content of living in greater or less degree for all mankind. It has already brought within men's grasp powers which our ancestors never dreamt were possible. The process is continuing at increasing tempo. Which of us can foresee the increase of these powers when men will become able to understand the working of the human brain more accurately and fully than at present? What potencies and increase of social well-being would not be possible, even now, if industry and government were to take the scientist into closer partnership?[2]

If faith in the orderliness and unity of the universe has made possible the growth of modern science, belief in the autonomy of the sciences and their freedom from external controls have been the condition of their rapid advance. The day of ecclesiastical controls is past, but the danger of political controls is very present, now that science and technology are entering into the economic and political spheres of life. The problem—the dilemma for society—is a real one. A wise solution will depend not a little on scientists and technologists themselves. Just as the early Christians were not in a position, and therefore did not have to concern themselves about government and the ordering of society, so were scientists in former days. Today, however, their moral responsibility towards society is no longer discharged

[1] C. A. Coulson, *Science and Christian Belief*, p. 64 and p. 30.
[2] Cf. F. E. Simon, *The Neglect of Science.*

by labelling the bottles and bombs 'Poison—to be handled carefully', and then leaving them about for any child, knave or fool to lay hands on. It is reassuring therefore to know that the Council of the British Association is alert to the new responsibility laid on its members in the contemporary situation.

Moreover, is it not important to remember that while knowledge like beauty is a desirable end in itself, yet *the* end is Life? Life not in the abstract, but in the concrete; not just my life or yours, but the life of the community living at full compass. Therefore the prayer of the wise man will not be, 'Give me understanding that I may know more and more', but 'Give me understanding that I may live'. Man is never just an observer, he is also an actor, responsible to man and God for his actions, and inaction. Knowledge, rightly used, will increase the goodness and worth of life, but the history of mankind does not allow us to assume that the mere knowing will insure true living.

'*This do, and thou shalt live.*' Here we have another, but not an alternative, response to reality and the demands of life; different, but not differing, complementary, not conflicting.

Christianity moves among those imponderables which the laboratory cannot measure and technicians cannot manipulate, but which we know from experience to be the very stuff of life—love and hatred, pride and humility, hope and despair, joy and suffering, beauty and ugliness, truth and the lie, the whole content of human intercourse and endeavour, both the tragedy and the comedy of life. As proclaimed and exemplified by our Lord Jesus Christ it is a call 'to choose, leap and be free'[1]—free to act courageously in the light of the true priorities in God's world. It is realistic about man's egoism, but not despairing; it recognises the need of even the most honest thinker to pray that the Spirit of truth may cleanse the thoughts of his heart, the need for the most courageous and saintly to be able to say, 'I am sorry, have mercy, forgive'; and the need of the ablest as much as the humblest, to know, 'my sufficiency is of God'.

Authentic Christianity is sharply distinguished, however, from the religions and pieties of escape which turn their back on life, fearing and thinking evil of what men perceive and enjoy through their senses. Its concern is not so much 'to save souls' as 'to make men whole', and to create and sustain a community within the total human society which will be at once its salt, its light and its leaven. When compelled in an emergency to choose it prefers mercy to piety—'this do and thou shalt live', but normally when free to choose it prefers that fine quality of thought and feeling—worship of the living God, that is completed in *acts* of justice, pity, love and peace.

The conviction of the Christian community, based on the promises of the Gospel and the experience of many generations, is that through such a corporate faith and worship men may receive the power to make wise choices, to act more unselfishly, and more nearly to love as God loves—a life which is life indeed!

The unfortunate conflicts between interpreters of Christian faith and modern science have nearly always happened because one or other, or both, have embraced what Whitehead called 'the doctrine of dogmatic finality'.[2] But once either or both allow that 'dogmatic finality of verbal expression is a mistaken notion', at least when pressed to an extreme, they can and will more easily walk together—not just co-existing, which is not good enough, but *co-operating*.

About that co-operation I wish briefly to say three things, if I may be so bold as to try to look into the future.

1. The fundamental need of the Western, quasi-Christian world is a new reformation of thought and belief which will give men once again a coherent world-view, and will help them to become integrated personalities living in peaceable

[1] The phrase is Kirkegaard's.
[2] A. N. Whitehead, F.R.S., *Adventures of Ideas* Chapter X.

communities. 'It was'—I quote Dr. Raven—'the precise combination of Hebrew religion and Greek science which gave to early Christianity its compelling power and won Europe for the faith.'[1] That world-view served its day, and is disappearing beyond recall. Today what is wanted is an integration of the faith preserved by the Church with modern science. For the present intellectual confusion is not just an academic problem: it is a social disaster. I would only add that the increasing specialisation of knowledge makes this task at once more urgent and more difficult.

2. Before this new re-formation can 'exercise compelling power' it will have to fashion new symbols, new art-forms, new imagery and so enlarge the language of poetry and Liturgy. In the life of the Church and in its out-reach into the world we are being handicapped because the old Biblical words and imagery, out of which its Liturgy has grown, are losing their potency in an age which is quickly gaining a new comprehension of the universe and of man. As yet we have nothing to take its place. Liturgy, the symbols and words of common worship, just because it is common and not private and peculiar, must always be slow to change. This process cannot be hurried. But I do not see a large renewal of public worship in industrial society—needful though it is for the health and wholeness of its life—until the new concepts and ways of looking at things have become part of the language, especially the language of poetry and imagination, out of which Liturgy grows.

3. The Church needs the scientist *in its midst*, not just for his good, but also to save it from the attitude of 'looking backwards every day' into which ecclesiastics, and indeed all institutions, when left to themselves, tend to slip.

There is one recurring note in the New Testament to which the scientific mind is likely to be more sympathetic than are those who would be content with an inelastic and rigid traditionalism. Nothing is more characteristic of the Gospels and of the New Testament than its faith in 'a God who comes' and its trust in the continuing ministry of the Spirit who dwelt in the Lord Jesus, to lead those who love Him to truer understanding and fuller life and to give them courage to press on beyond old frontiers.

Curiously, the one basic belief of the Church which has not yet been well thought out and understood is the belief in the Holy Spirit. And yet the Holy Spirit is the creator of the Church, and as Canon Vidler has written 'is its lifegiver, its reformer and tormentor, and at last its only resource'.[2] F. D. Maurice, that great prophet and professor of our Church in the nineteenth century, declared years ago 'I cannot but think that the reformation in our day, which I expect is to be more deep and searching than that of the sixteenth century, will turn upon the Spirit's presence and life.' In the Providence of God that day has tarried, the doctrine of the Spirit has still to be thought out. May that not be because its full comprehension requires the new light and knowledge which science is bringing?

In conclusion, just this; a week or two ago in the Alps, I read a pregnant little book by Sir Russell Brain which closed with this sentence, 'Man, while looking on the world with the cold eye of scientific vision still needs to be carried forward by the vital forces of the older modes of knowledge'.[3]

'Still'! In what sense? Not, I would say, meaning just for a time because one day science will close the gaps and render the older modes, including faith, obsolete and unwanted. No! Until the end of history man will have to walk by faith as well as by sight because he is an actor as well as an observer: and to act rightly he needs forgiveness as well as confidence, love as well as learning, the power of the Spirit in order to live in a community of integrated personalities as a child of the invisible God who in one blessed moment of light revealed Himself in the living, dying, rising to life again of Christ Jesus—the Lord in and through whom we have much joy.

[1] Charles Raven, *Science, Religion and the Future*, p. 124.
[2] A. C. Vidler, *Christian Belief*, p. 73, and see the whole of Chapter IV.
[3] W. Russell Brain, *Mind, Perception and Science.*

CURRENT TRENDS IN FOREST RESEARCH IN BRITAIN[1]

ADDRESS BY M. V. LAURIE, O.B.E.

CHAIRMAN OF SUB-SECTION K*

THE pattern of Forest Research in Britain has been changing of recent years, and seems likely to change even more in the next decade or so. I thought it might be interesting to examine briefly the main emphasis of forest research in the past and up to the present, and to indicate the changes in general trends that are taking place —probably to a greater degree now than at any other time since organised forest research started in this country. In doing this I shall consider three periods, namely, the time before the first world war, the period from 1919 up to the end of the second world war, and the period from 1946 to date.

The background of forestry practice in Britain is different from that in most other countries. In the eighteenth and nineteenth centuries there was little managed forest in the modern sense of the word. Most of our natural woodlands had been destroyed in the previous centuries, and, apart from a number of enlightened landowners who, through their personal interest and individual efforts planted forests and experimented with a wide range of exotic species from different parts of the world, there was no organised forestry in Britain. These landowners did, however, accumulate a great deal of valuable information on what species would grow well in this country, and on the methods of making successful plantations. Forestry, in the hands of these men became an art, and was practised as an interesting recreation rather than a business. It was generally carried out on types of ground much more favourable to tree growth than most of the land now available for planting. It reached its highest development in the late eighteenth and early nineteenth centuries, but under the impact of growing industrialisation followed by wars and heavy taxation which brought about the collapse of the large estates on which it had all along been based, the old forestry suffered a blow from which it never recovered. During that time there was no organised forest research.

In the thirty years following the first world war, which saw the development of a clear forest policy for Britain and the formation of the Forestry Commission, organised forest research started in a small way. It was mainly occupied with solving the immediate problems concerned with the formation of new forests on the types of land that became available for planting. Much of this was heather moorland, or peatland either of a grassy type or dominated by heather, and these presented entirely new difficulties not only in the selection of species but in the methods of preparing the ground for planting, the necessity in some cases of using phosphatic manures and the need, especially where spruces were planted, of ensuring that heather was suppressed as soon as possible. Details of the results of twenty-five years' research work on peatland afforestation have recently been published as a Forestry Commission Bulletin, and a similar compilation on heathland afforestation is nearly ready. These publications represent the culmination of a phase of intensive research into the *ad hoc* problems of afforesting difficult sites, which has resulted in the present techniques of deep ploughing, draining, phosphate manuring and of the use, among other things, of *Pinus contorta* as a pioneer crop on difficult peats and infertile heaths.

During this phase of research work, the importance of the provenance of some

[1] Address delivered on August 30, 1956, at the Sheffield Meeting of the British Association.

of the species we used began to be appreciated. European larch from Alpine origins was often found to die back when it closed canopy, while central European and the old Scottish strains remained relatively healthy and vigorous. Douglas fir of inland origins was found to suffer from *Rhabdocline* and to grow unhealthily while coastal strains were relatively immune even though they suffered more from the attacks of *Adelges cooleyi*. *Pinus contorta* from different places not only showed extreme variation in growth form and in vigour varying from the strongly growing bushy types of coastal origin to slender, straight, slow-growing forms from inland sources, but they also exhibited variation in susceptibility to diseases. Sitka spruce, our most widely planted species, while showing no very obvious differences in vigour or form due to its origin, seems to be a little more frost tender when introduced from the south of its range in Washington than from the Queen Charlotte Islands further north, and there is a suspicion, one cannot call it more than that, that the timber quality of the southern origins may be slightly inferior when grown in Britain. It appears, in general, that wherever a species in its natural habitat has a wide range of distribution, differences will develop in vigour, growth form, resistance to disease, suitability for particular conditions, and timber quality that may make the correct selection of seed origin of the greatest practical importance.

During the last ten years of this early period of research, provenance experiments were laid down for nearly all the more important species we were growing in this country. The selection of provenances was initially in many cases rather haphazard, but in the later experiments a more conscious effort has been made to cover the range of conditions in the native country of the species that are likely to be of significance when the tree is introduced into Britain. The basic data on which to judge such matters is, however, very meagre, and it is still very much a matter of spreading one's net wide in the first instance, and later, when the experiments begin to give some guidance, of concentrating on the range of localities that promises to give the best results.

Another matter that received a great deal of attention during this first period was the development of satisfactory nursery techniques for all our commonly grown species, and the practical problems of nursery cultivation, density of sowing, method of covering the seed, transplanting, age and type of plant to use for planting in the forest, and so forth, were mostly satisfactorily solved. It was found, for instance, that seeds of certain species such as Douglas fir needed stratifying in damp sand before sowing, that seeds of many conifer species would only germinate well if covered with silt-free sand or grit, and that care had to be taken to cover the seed to the correct depth. It was also found that for most conifers, transplants that had had two years in the seedbed and one or sometimes two years in the transplant lines were best, that certain species seemed to require shading, and so forth. These were all matters of practical detail that had to be worked out. A number of nursery problems were, however, unsolved at the end of this period. The maintenance of fertility in nurseries was giving cause for concern, as also was the excessively high cost of weeding particularly in nurseries on old agricultural soils.

In the fields of Pathology and Entomology a number of the commoner diseases and insect pests were identified and described, and their life-histories worked out, but the total effort applied to those subjects was relatively limited. Very little fundamental work was done on the ecology and epidemiology of pests and diseases, and, apart from being able to recognise them when they occurred, and to associate them with certain general conditions, species or provenances, little more could be done to advise foresters how to cope with a disease or a pest when it got troublesome. Fortunately, practically no really serious epidemics had broken out though *Adelges cooleyi* on Douglas fir, *Evetria buoliana* on pines, *Neomyzaphis* on Sitka spruce and *Pristophora erichsonii* on larch had all caused short-lived alarm at times. The attacks of *Adelges nusslini* on the European Silver fir had, however, proved so serious as to

make the planting of that species uneconomic, and the blister rust, *Cronartium ribicola*, had similarly made the valuable Weymouth pine not worth planting. In general, however, there was a feeling that with the still relatively small acreages of pure plantations that we had at that time, along with the considerable areas of mixed woodlands, hedgerows and other woody vegetation, the chances of disastrous epidemics of forest insects, such as occur regularly on the Continent, were small and we were fairly complacent about the situation.

In forest mensuration, the collection of data through the regular remeasurement of permanent sample plots for the compilation of yield tables was pursued very much on the classical lines established on the Continent. Volume tables were made for our more important species and much of the basic statistical data needed for future management and for setting standards of production was collected. Of forest management in the usually accepted sense of the word there was little, since the forests that had so far been created were nearly all too young for management problems to become important.

To summarise, the period from 1919 up to the end of the second world war was mainly spent in solving the immediate practical problems of afforesting the types of land that were being acquired for planting and in collecting preliminary basic data on the production of the various species of trees in different sites and on the main diseases and pests that were encountered.

After the second world war there was a great acceleration in the tempo of forest research activity. Not only did the Forestry Commission establish its Research Station at Alice Holt and a branch in Edinburgh, but there was a notable increase in the amount of research into the more fundamental aspects of Forestry in the Universities and other research institutes—much of it supported by grants from the Forestry Commission. Though at first the range of subjects covered was essentially the same as before, new fields of work soon began to be developed, and the present picture is very different from what it was in 1946. It is, of course, impossible in the space at my disposal to describe these developments fully, so I shall confine my observations to some of the more important projects.

In Silviculture, owing to the new legislation designed to encourage better forestry in privately owned woodlands, the rehabilitation of derelict woodlands became a problem of urgent importance. These derelict woodlands are mostly of a deciduous type. They cover about one million acres and are mainly concentrated in the midlands, the south and west of England and in south Wales, and are largely in private ownership. The exploitation of trees of valuable species during the two world wars and between them, with, usually, no conscious effort at regenerating them, resulted in a mixed regrowth of largely useless species. The disappearance of markets for coppice of hazel and oak, and a reduction in the market for chestnut coppice also contributed to considerable areas of this mixed broadleaved forest going derelict. The sites on which they occur contain some of our best forest-soil developed under favourable woodland conditions and should be among our most productive areas. The particular problem in rehabilitating them consists mainly in dealing with the vigorous regrowth of broadleaved trees and shrubs which are either useless or of low value—birch, hazel, field maple, badly formed oak and sycamore coppice, ash on ground unsuited to it, thickets of blackthorn or whitethorn and so forth. Other types are covered with rampant growth of rhododendron or laurel originally planted as pheasant coverts, but now run wild. The replacement of these types of growth with a productive forest is mainly a problem in economics. It is very expensive to clear such areas for planting, often costing more than most private owners can afford, particularly if done by hand; and when cleared, a long and expensive battle ensues in which coppice regrowth from the stumps of the cleared trees has to be repeatedly cut back to enable the planted trees to get ahead. Investigations into the ways and means of tackling this problem have taken several forms. First, a large

number of carefully costed experiments have been laid down in a range of different types of derelict woodland at different stages of development in which complete clear cutting and planting is compared with various methods of partial clearing, in strips or patches of various sizes. First indications suggest that the savings in initial cost of partial clearances are likely to be more than offset by the extra cost of cutting back on the edges of the strips and groups and by the less complete crop that is ultimately established. The use of very large plants, 4 to 6 ft. high, in small gaps is being experimented with, as well as underplanting with shade-bearing species in thinned-out scrub that has been allowed to grow up and form a canopy. To reduce weeding costs, investigations are being pursued in the use of arboricides and promising results are being obtained with some of the more recently developed formulations for use as sprays on cut stumps to prevent regrowth, or as basal bark sprays to kill standing poles and scrub of unwanted species. Following the general indications that complete clearance is often preferable to partial clearance wherever it can be afforded, trials are being made of various methods of mechanical clearance using heavy machinery with grubber blades or specially designed cutting blades. The clearance of scrub using a heavy anchor chain drawn between two powerful tractors has shown promising results in certain types of growth, but the economics of all these mechanical methods of clearing require further working out, and depend to a great extent upon the availability of large areas for clearance within a reasonable range. The stage reached now in this derelict woodland work is that a sufficient spread of experiments in partial clearance methods has now been established and it needs only time for the results to come in. More work is required on mechanical clearance of scrub and on the economic control of woody growth by chemical means. One factor which, locally, may alter the whole aspect of rehabilitation is the discovery that these miscellaneous hardwoods can be used economically with the bark on for the manufacture of pulp. Regarding the species to be used in rehabilitation, it is clear that broadleaved hardwoods cannot be grown profitably except on the very best hardwood soils, and even then are less profitable than conifers. The private owner, who has his pocket to consider, will therefore in most cases prefer to grow the higher yielding conifers, which are, at the same time, more urgently needed in the national economy, and even on the best hardwood sites he will probably use conifers as nurses and catch-crops, along with his hardwoods, to help pay for the expensive operation of rehabilitating these derelict woods and getting them back into production.

As mentioned, the primary problems of establishing forests on the peat and heathland sites of which the majority of land available for afforestation has so far consisted, have mostly been solved. Attention is now being directed to particular problem areas, such as some of the grassy heaths in central Wales and the dwarf gorse types in Devon and Cornwall which present special difficulties, and to the smoke-polluted areas in the industrial Midlands, where considerable stretches of land would be available for afforestation if we could discover species that will stand the effects of sulphur dioxide and other toxic constituents of industrial smoke. The excessive exposure and generally poor soil conditions experienced in these areas contribute to the difficulties. A number of planting experiments have been laid down, and a beginning has been made in measuring the levels of pollution over a wide range of sites, but much more intensive work is required on the physiology of plant reactions to smoke. We do not know, for instance, whether the damage is cumulative on account of continued pollution at a moderate level, or whether the main damage occurs in short periods of excessive concentration lasting possibly only a few days or hours. There seems to be a profitable field for joint research between agriculturists and foresters into the phytotoxicity of industrial smoke, as it is known that it seriously affects the growth of grass and other agricultural crops as well as trees.

In Pathology, work has, till recently, continued much on the same lines as previously. New diseases occur from time to time and it is a matter of intensive study, first to discover the cause which is often obscure, and then, to study the ecology of the disease, so as to be able to suggest how to prevent it. There is scarcely ever any opportunity for suggesting a cure for forest diseases once they have occurred and the pathologist's job is primarily to define the conditions under which a disease develops or becomes virulent, so that they can be avoided. In some cases active preventive measures can be taken, e.g. by the treating of stumps of thinnings in pine plantations to prevent the spread of *Fomes annosus*, or by spraying in nurseries, though no effective sprays have yet been found to control two of our worst nursery diseases, *Botrytis cinera* on a wide range of species, and *Keithia thujina* on *Thuja plicata*. Of forest diseases, several new ones have been studied, for example, a 'group dying' of Sitka spruce which has been traced down to attack by the fungus *Rhizina inflata*, arising from the sites of old fires, a 'top dying' of Norway spruce, and a resin bleeding of Douglas firs, to mention only a few. The causes of the last two are still obscure. None of these, however, has resulted in widespread damage. Looking to the future, however, one fungus which is likely to cause serious havoc when our plantations get older is *Fomes annosus*, both by killing trees and by causing heart rot, and an intensive long-term investigation of this fungus has just been commenced.

In the Entomological field, activity has greatly increased during the last few years. Our complacency was shaken by the recent epidemic outbreak of the pine looper in Cannock Chase, requiring control by aerial spraying to save serious loss. As a result it has been found necessary to keep a check on the population of this species in pine forests all over the country by means of pupal counts during the winter. More intensive watch-dog activities have been instituted in different parts of the country to try and spot, in time, potential danger from any of our commoner insect pests, and as a result a number of previously unsuspected insects have been found to exist in numbers that might become important if conditions for their development were particularly favourable. More work is being done on the detailed ecology of one or two of our most dangerous insects but this work is laborious, and the available workers so few, that the progress that can be made is at present limited. From the general forestry point of view the situation is definitely one in which, with our larger areas of pure crops, the possibilities of epidemic attacks developing are greater than before, and our best insurance under present conditions is greater watchfulness on the part of all foresters and forest entomologists so that any abnormal increases in the population of any of our pests can be spotted at a very early stage.

Another subject which has recently received and continues to receive a great deal of attention is the study of poplar growing. Many farmers and owners of land have odd corners of good soil that cannot conveniently be put under arable crops or grass, and which are eminently suitable for growing poplars. These are grown as individual well-spaced trees rather than as forest crops, but owing to their exceedingly rapid growth and the great demand for poplar timber for matches, chip-baskets and a number of other special purposes, they produce a good return in a short time. Unfortunately, many of the fastest growing poplars are subject to disease in this country, and are at the same time particular about the soil condition on which they are planted and the way they are treated. Considerable effort has gone into poplar breeding on the Continent, and in Canada and the U.S.A., and a very large number of species and hybrids have been produced. Fortunately, poplars are very easily raised from cuttings, and stocks have been raised from over 300 different clones for testing for disease resistance, rate of growth, straightness of stem, and suitability for various soil conditions. We are now able to recommend several varieties suitable for planting in this country that are disease resistant and,

on suitable sites, give rapid returns of good straight timber. Work has simultaneously been proceeding on the silviculture of poplars, the best ways of raising them in the nursery, the size and type of stock to use, the methods of planting and manuring, the best spacing and methods of tending so as to produce the highest returns. Some people would not regard poplar growing as forestry, so much as arboriculture, and very little poplar growing, apart from experimental trials is done by the Forestry Commission. The results of these investigations are, however, of value to the private owner who wishes to get a quick return from odd corners of available land of suitable quality.

In forest nurseries, attention has been directed in particular to problems of tree nutrition and to the maintenance of fertility. It has been found that in many nurseries, especially on old agricultural soils, fertility cannot be maintained merely by the use of fertilisers or the application of bulky organic manures or composts, and a condition often sets in under which the growth of conifer seedlings is seriously inhibited. This condition has been investigated and it has been shown that sterilisation of the soil, either by steam or by chemicals such as formalin, or chloropicrin, restores the fertility for a time at any rate, and the plants once again react to the addition of fertilisers and manures. The causes of this state of 'conifer sickness' of the soils, and the mechanism of its action and its cure by sterilisation, are not yet properly understood. Intensive work on the soil fungi that exist before and after sterilisation, and their action on the seedlings suggests that though a part of the 'sickness' may be due to parasitic fungi attacking the roots of the seedlings, this is not enough to account for the main effect, and some other cause must be looked for. From the practical forestry point of view, partial soil sterilisation using formalin is now frequently practised. Experiments to find the cheapest effective methods of application are in progress, and alternative sterilising agents are being tested.

A great deal of work has been directed to the nutrition of tree seedlings and transplants in nurseries, both in the agricultural soil nurseries mentioned above and in heathland nurseries. It was fortunate that, largely due to the pioneer experiments of the late Dr. Rayner, who raised healthy seedlings on a very sterile sandy heathland soil at Wareham by means of liberal application of composts, a technique of growing tree seedlings on acid sandy soils, either on heathland or on old cleared woodland sites, has been developed, and these heathland nurseries have to a great extent replaced the established nurseries on old agricultural soils for raising seedlings. Nutrients are supplied either in the form of raw hopwaste, composted hopwaste, pure or mixed with bracken, or in the form of inorganic fertilisers, which are much cheaper but which need more care in application. Minor or trace element deficiencies have recently been diagnosed in some of these heathland nurseries, notably magnesium on several occasions causing a sort of tip-burn to the seedlings and, in one case, copper deficiency. The major part of the research work on which present manuring practices in all types of forest nurseries is based was carried out by the late Dr. E. M. Crowther of Rothamsted Experimental Station. Much help was also received in Scotland from the Macaulay Institute for Soil Research, and there is no doubt that great improvement in forest nursery technique throughout the country has resulted from this work. As an example, it is now regular practice to use one-year-old seedlings of many species for transplanting, whereas, formerly, two-year-olds were normal, and this has resulted in great saving in the cost of plants.

The intensive work on the nutrition of nursery seedlings and transplants arose, when it did, largely as a result of a controversy on mycorrhiza. Dr. Rayner, who by her composts raised excellent seedlings on sterile heathland soils, found that these seedlings had mycorrhizal associations on the roots and she attributed a large part of the growth and health of the plants to this mycorrhiza. Dr. Crowther, on the other hand, considered that the result was mainly due to the nutrients so abundantly

supplied by the composts used in raising them, and after some experimentation was able to grow just as big seedlings on the same soils using mineral fertilisers only. Many of his seedlings, however, became mycorrhizal, though root examinations from a large number of experiments did not demonstrate any clear correlation between the health and growth of the seedlings on the one hand and the presence of the mycorrhizal habit on the other. A study of mycorrhizal fungi, started by Dr. Rayner, has been continued by Dr. Levisohn at Bedford College, who has demonstrated a decided stimulus to growth by the presence of mycorrhizal fungi, whether they have actually formed mycorrhizas, or whether they are merely present in the soil without forming any actual associations. The watering of roots with the leachings from pots containing mycorrhizal seedlings has also been shown to cause the typical forking of the rootlets that is found in mycorrhizal plants, again without any formation of a mycorrhiza. It has even been shown that trees like Lawson's cypress, that normally have an endotrophic mycorrhiza, are stimulated by the presence of an ectotrophic mycorrhizal fungus in the soil, though the converse effect has not been demonstrated. The whole mycorrhiza story is obviously complex and fascinating. In this country tree seedlings often apparently grow happily without mycorrhizas, though they usually pick them up sooner or later. In other countries, notably Australia and South Africa, the importation of specific mycorrhiza forming fungi along with exotic tree species, has been found obligatory for survival. There are at least two separate effects to be taken into account, namely, the rhizosphore effect in which the fungus can sometimes stimulate growth without actually forming a mycorrhiza, and the effect of the fungus on nutrition after it has formed a mycorrhizal mantle round the roots. Much more fundamental research work is necessary before the status of mycorrhizal fungi in tree nutrition and the way in which they act can be elucidated.

To return, however, to research in nursery techniques, a very important advance of recent years is the introduction of selective weedkillers. Weeding is the most expensive operation in raising either seedlings or transplants and, after extensive testing of a large range of substances, weed control by pre-emergence spraying of seedbeds with tractor vaporising oil, or similar oils, has become standard practice in most conifer nurseries and has resulted in great economy in weeding costs. This operation can be safely followed up in beds of some species, notably Scots and Corsican pines, Norway and Sitka spruces, *Thuja* and Lawson's cypress, with post-emergence sprays of white spirit; but other coniferous species, particularly *Pinus contorta*, the larches, *Tsuga*, Douglas fir and the Silver firs are more susceptible to such post-emergence treatments and may be damaged unless lighter applications are used. In both pre- and post-emergence sprays, care has to be taken to use an appropriate dose, as considerable losses may be caused by too heavy applications. Inter-row spraying of conifer transplant lines with similar phytocidal oils has also proved effective and economical for weed control. Hardwoods have, however, been found to be susceptible to the types of oil sprays that are used for conifers, and no safe selective weedkiller has so far been discovered for use in hardwood nurseries. The search is continuing for more effective weedkillers with an even higher degree of selectivity, and consideration is also being given to discovering total weedkillers that can be used to keep fallow areas clean, but which do not leave unwelcome toxic residues behind them.

The subjects I have so far mentioned as examples of post-war research do not, however, indicate the major trends of research which differentiate it from that of previous years. I refer to the much greater emphasis that is now being placed on long-term problems, the results of research into which may not bear fruit for many years.

In the nursery, although nutritional studies have enabled us to devise satisfactory manuring regimes and other treatments for raising good crops of seedlings and

plants, the long-term effects of these practices are not known. It has been suggested that the abandonment or reduction of the use of heavy dressings of bulky organic manures may result in a gradual or even a rapid deterioration of fertility. At the same time the value of green crops during the fallowing period between conifer crops has been questioned. The late Dr. Crowther has designed and laid down complex rotational experiments geared to run for twenty years or more which should answer many of the criticisms that have been levelled at the prescriptions for nursery manuring now adopted, both for the acid heathland nurseries and the old-established nurseries on agricultural types of soil.

In the forest, the preoccupation with immediate afforestation problems is giving way to more distant but, in the long run, probably more important matters of the effects of forest crops on the soil. It is a fundamental responsibility of a forester, just as it is of a farmer, to preserve and, if possible, improve the productivity of the land on which he grows his crops, but in forestry the changes in the soil are far slower and insidious degradation may take place over many years before it is noticed.

Dr. Ovington, of the Nature Conservancy, has been amassing basic data of the balance sheet, as it were, of nutrients in the soil, in the tree crop and in the undecomposed litter and has obtained some valuable preliminary information on the different requirements of a number of species and the amount of the nutrients that are locked up in the litter. At the Imperial Forestry Institute, Oxford, Dr. Handley is working on the constitution of litter of both hardwoods and conifers and is investigating the particular substances that prevent the ready breakdown of the cellulose in conifer litter by fungi. At Rothamsted, Dr. Murphy is working on the mesofauna of the soil, the mites, collembola and other small creatures that feed in the litter, and is endeavouring to ascertain the part they play in the tree nutrient cycle. Dr. Leyton, at Oxford, is studying the conditions affecting the uptake of water and nutrients by tree roots and, as mentioned, Dr. Levisohn is working on the mycorrhizal relationships of tree roots, while Dr. Wright, at the Macaulay Institute, is investigating the changes that take place in soils after afforestation. There is thus considerable activity which has sprung up since the war in the study of the basic processes of tree nutrition and the interaction between trees and soil. At Alice Holt, a soils section has been recently added which will not only be able to do soil and foliar analyses to elucidate conditions and effects in silvicultural and pathological investigations, but which also proposes to collect data for forest crops of differing site quality on both the nutrient status of the soil and the nutrient content of the whole tree. By combining these investigations with experiments in the addition of fertilisers to supply any nutrients of which there appears to be a shortage, a great deal of useful information should be gained not only on the limiting nutrient requirements of different trees but also on the nutrient status of planting sites and the crops they may be expected to produce. There is here a vast field for research, calling for a co-ordinated effort from a number of research workers using standardised procedure if rapid progress is to be made.

On the silvicultural side, these long-term problems are being approached more empirically. Plans are being made for following through the growth in sample plots of a species from one rotation to the next to see what changes in productivity may have occurred. Mixture experiments are being laid down to compare the growth of mixtures with that of pure crops of each of the constituent species. These experiments will provide contrasting conditions for the study by soil scientists of the effects on the soil of mixtures *vis-à-vis* pure crops. A great deal has been written from time to time about the effect of mixtures either in the upper canopy or as understories on the growth and production of a crop, but on analysis, it nearly all consists of opinions based on a study of the mixtures by themselves. There is practically no reliable comparative data showing the differences between pure crops and mixtures that has been derived from acceptably planned experiments. A start has

now been made in this country. Apart from their possible effects on the soil the mixtures present particular silvicultural and management problems. Many attempts at raising mixtures in the past have failed owing to one of the constituent species outgrowing and suppressing the others. Such results are usually due to too intimate mixing at the beginning and more work is needed to find out the best ways of raising mixtures so that their constitution can be easily controlled in later life. More knowledge is also required of the species that will grow happily together and which, either by their different rooting habits or by the different forms of litter they deposit are likely to make better use of a site and maintain better conditions than either species grown singly.

Now that a greater proportion of the forest crops in this country are reaching the pole stage and starting to produce small timber, thinning research is becoming more important. Most foresters will say that they can go into a crop and mark a thinning that is just what the crop needs, so why all this fuss about defining thinning grades, by complicated schedules of tree classes to be removed, or by calculated stand density indices? One only has to look at the results of past thinnings, however, to realise that there are fashions in thinning, the pendulum swinging violently from very light to heavy thinnings, with occasional departures from the more orthodox 'low' thinnings to different conceptions of 'crown' thinnings. According to present ideas, the latest yield tables for conifer plantations in Britain are based on too light thinnings, and diameter increment is thought to be unduly restricted on that account. Comparative thinning experimental plots have been laid down in large numbers since the last war, supplementing those laid down between the wars. They have usually consisted of one very light, one fairly normal, and one heavy, low thinning grade, plus, in some cases, a crown thinning. It has been shown that, provided all the measurements are made down to a sufficiently small diameter, the total yield per acre is scarcely affected by different thinning grades and that the main result is to alter the assortments of sizes of produce that come out of the forest at different periods of its life. From an economic point of view this may be exceedingly important as, in the case of saw timber production, there will be an increase in the price per cubic foot for larger sizes and, if questions of interest on the capital invested in a forest are considered, as they well may be, particularly in private forestry, the need to produce large timber as quickly as possible tends to encourage very heavy early thinnings. This also raises questions of the quality of the wood produced. The usually unavoidable wide-ringed core in plantation crops, which is laid down before the canopy closes, results in low quality timber if it is surrounded immediately by a layer of much slower grown timber—a condition frequently found in plantations where first thinnings have been delayed or have been too light. There is little doubt that thinning regimes should be adjusted so as to keep the trees growing vigorously and avoid sudden changes in rate of growth. At the same time there is a controversy going on about the quality of fast-grown timber, though it appears that speed of growth is not the factor that mainly affects timber density and strength. In any case, even in our best site quality classes, when heavily thinned, the average annual ring widths on the older trees will not be excessive. It has been suggested that thinning research should now pay more attention to the kind of timber it is aiming to produce, rather than merely to compare thinning grades and see what happens.

A related development in forest research since the war is the greater attention that is being paid to timber quality. Close liaison has developed between the Forestry Commission and the Forest Products Laboratory at Princes Risborough, which is not only doing a great deal more testing of the strength and other properties of the trees we are growing, but are also researching into such matters as the distribution of the density of wood in the tree, the effect of rate of growth on density, etc. Other workers, notably Dr. Chalk, at Oxford, are studying the conditions under which summer wood is laid down in the tree ring, and, in general, a greater

appreciation of the importance of timber quality in the trees we are producing has arisen.

Another branch of forest research with its eyes on the distant future, that has sprung up since the war, is that of tree breeding, or, forest genetics. It is common knowledge that, of all the crops cultivated by man, trees or forests have, until recently, been practically the only one that has been neglected by the breeder. The natural variations that exist in our trees, both between individuals and between strains or races of different origin is considerable, and is a fruitful field for selection and breeding; but little conscious advantage has been taken of this until very recently, and the tendency to collect seed from our heaviest bearing trees which are usually the branchiest with the worst growth form has, in the past, probably had a definite disgenic effect. The approach to the problem of tree improvement in this country is essentially a practical one aiming firstly at getting a limited improvement in as short a time as possible. The higher flights of applied tree genetics, which should result ultimately in greater improvements, but which will take more time and work to achieve, will follow later. The first stages have been the classification of the older existing tree crops in this country into 'plus', 'normal' and 'minus' stands for seed collection with the object of restricting seed collection as far as possible to the 'plus' or superior stands. This will probably result in a limited improvement. The second stage has been to select individual 'plus' trees, according to very strict criteria. To be classified as 'plus', a tree must be much superior to the other trees around it in the crop in which it is growing in vigour, straightness of stem, fineness of branching and any other particular characters for which we may be looking. Vegetative material from these 'plus' trees is grafted on to uniform stocks and is used firstly to put into tree banks, so that, should anything happen to the original tree, it is preserved for future use. Secondly, it is planted out in replicated trials to see whether its apparent superiority is really inherent or merely phenotypic and, thirdly, those with inherently good characters are planted out in 'seed orchards' in which grafts from at least twenty 'plus' trees of a species are mixed up together. Seed produced by free pollination in these seed orchards should have genetically a higher average quality than seed from either the old forest collections or the selected 'plus' stands. It is hoped that the major part of the seed requirements of this country will be produced under controlled conditions in this way within fifteen to twenty years.

The next stage will be to do controlled cross-pollination between individuals in the seed orchards, and carry out progeny trials with the seed. In this way trees that are good breeders can be separated from those that are bad breeders, and the latter eliminated from the seed orchards, thereby still further improving the average genetic quality of the seed.

At the same time as all this is going on, trials of hybrids between selected parent trees of closely related species, or even between different provenances of the same species, are being made in a small way, and are likely to produce some very useful results. This side of breeding, with all its possibilities of producing new combinations with outstandingly useful characteristics, will gradually receive more attention once the earlier stages of the improvement mentioned above have been completed. The conditions for realising the fullest advantage from tree breeding are present in this country, where so large a proportion of our forestry consists of the creation of new forests. One can only regret that tree breeding was not started earlier, so that a larger proportion of our new crops could have benefited from it. The work is still in its infancy, and the benefits to be expected from it should begin to be significant in the crops planted from about 1970 onwards.

Now that the forest crops established in the early days of the Forestry Commission are starting to produce wood in ever-increasing quantities, the problems of management and economics are beginning to become important. A management study

section, and a work study section have recently been established. The former will be concerned in investigating the best ways of managing our existing forests from the point of view of adjustment of age-class distribution and treatment of the stands, so as to work towards a steady yield with the least sacrifice of potential increment, and in devising the types of working plans and control measures best suited to our particular conditions. The work study section has a wide field of research into improving the efficiency of forestry operations of all kinds, from the work of the single man to the organisation of complex operations. And to work along with both of these, a Forest Economics research section in the Forestry Commission is now being considered. Studies have, incidentally, been going on for the past five years or more, by workers at Oxford and Aberdeen, into the costing of operations on private estates throughout the country and have already produced a great deal of valuable information.

In conclusion, therefore, it will be seen, from the rather sketchy survey of forest research work I have described, that several fairly clear trends in forestry research in this country emerge which involve a notable change in emphasis in the work. Firstly, short-term problems are tending to give place to long-term problems in which the results may not be obtained within half a rotation or longer. Secondly, a start has been made in tackling a number of the more fundamental scientific problems in forestry. This work is still on a small scale, but will probably increase and will add to our basic knowledge of the fundamental life processes of trees, their nutrient requirements, and their interactions with the soil and the whole biological complex in which they grow. Thirdly, the business aspects of forestry are now becoming more important as is evidenced by the greater attention that is being paid to the quality of the wood we are producing, to management problems, to the development of machines, to the work study that is commencing, and to the costing work, and other economic investigations that are being started.

There may perhaps be some regrets that, in this material age, the business side of forestry is coming more and more to the fore. This is inevitable, as forestry is primarily a business. Scientific research is continually settling controversial points and replacing opinions by factual knowledge. There is still, however, such a vast field of the unknown, and the reaction of trees and crops to their environment is still so imperfectly understood, that there is yet scope for beliefs, both orthodox and heterodox, that can lead to interesting arguments and exhibitions of individuality in forestry practice.

ASSEMBLY OF CORRESPONDING SOCIETIES
SECTION X
SHEFFIELD, 1956

THE opening session took place on Thursday, August 30, with the Presidential Address, when, speaking on the 'Local Society in the Community of today', Dr. F. J. North, O.B.E., surveyed the changing fortunes of Local Societies as the conditions which obtained when many of them were founded gave place to those of today. Local Societies, he remarked, had suffered from (amongst other things) competition due to the increased number of cultural organisations and the coming of the cinema, sound broadcasting and television, as well as from the diminishing contribution which the amateur could make owing to the increase of specialisation. Their survival depends upon their willingness and ability to adapt themselves to present-day conditions and to take advantage of the increasing interest in scientific matters aroused by the media that at first glance may seem to be devastating competitors.

After the Presidential Address, Mr. Harold A. Hems (Sheffield) spoke on some problems confronting the nature photographer who wished to explore new fields, and illustrated his talk by a series of colour films of small invertebrates (e.g. ants, bees and wasps) in action, and of life in rock pools.

Mr. James J. Swift, a Charterhouse boy, followed by describing his experience as an observer at the breeding site, in a Sussex sand-pit, of the first bee-eaters to nest successfully in the British Isles, in 1955.

On Friday, August 31, Dr. H. T. Himmelweit, of the Nuffield Foundation Television Enquiry, reported on a study of the effect of television on children. Her enquiries suggested that it was unlikely that the majority of children were becoming 'TV addicts', but were on the other hand tending to select their programmes. She expressed the opinion that the accusation regarding the ill-effects of television were similar to those formerly made against sound radio.

Miss B. R. Winstanley, organiser of the Museum Service for Derbyshire Education Committee, then spoke on 'The potentialities of television as a medium in the education of children'. She said that neither the good telecast nor the good film could take the place of the teacher although they could provide valuable supplementary material, and asked whether it would be altogether a bad thing if television enabled children to study text-books for necessity a little less and encouraged them to read literature for pleasure a little more.

In the afternoon, Mr. H. G. Hurrell gave an account of ranch-bred pine-marten which had been so trained as to be given liberty in a natural environment. His talk was illustrated by slides and colour film which recorded, amongst other things, the extraordinary agility of the creatures.

Dr. Trevor D. Ford followed with a survey of the mode of occurrence, physical characters, and mining of Blue John in the Castleton area of Derbyshire. His talk, illustrated by colour slides, included an account of the discovery and use for ornamental purposes of this unique variety of fluorspar.

On Saturday, September 1, a whole day excursion was made, encircling the limestone plateau of North Derbyshire, under the leadership of Mr. Denis Price. The route, which lay through Matlock, Ashbourne, Longmor, Buxton, and the Hope Valley, permitted visits to be made to Chatsworth House and the Stone Circle at Arbor Low.

On the afternoon of Sunday, September 2, a visit was made under the guidance of Dr. Ford to Treak Cliff at the northern end of the Derbyshire limestone plateau,

in order to inspect the cavern from which Blue John has been obtained for many years and which is now the only place where it is mined for ornamental purposes. The visit included the inspection of a series of stalactite caverns discovered when excavations were made in search of fluorspar for industrial purposes.

On Monday, September 3, a general discussion on the Presidential Address was opened by Professor A. R. Clapham (Sheffield), who drew attention to the part which members of local societies could play in a national botanical survey. Professor S. W. Wooldridge, C.B.E., referred to the potentialities of co-operation between local societies and the Council for Field Studies, and the importance of introducing new blood into local societies by the formation of junior sections was stressed.

The remainder of the morning was devoted to a paper by Mr. S. D. Cleveland, O.B.E., Director of the Manchester Art Gallery, on 'The artist and the countryside'. Using a series of lantern slides showing the development in Europe of the artist's interest in landscape painting he demonstrated the part played by nature in inspiring picture-making. He compared the conception of landscape of European artists from the fourteenth century to the present time, and indicated differences between the national and the individual outlook.

The morning session was followed by the Section luncheon in the restaurant at Whirlow Brook Park. It was attended by thirty members and provided an opportunity for them to meet next year's president of the Section, Professor D. A. Webb.

In the afternoon, the Section visited Eyam, one of the villages in the Derbyshire limestone country which perpetuates the tradition of 'dressing' its wells with elaborate floral panels, one of which referred directly to the British Association. The purpose and preparation of the panels was explained by Mr. C. Daniel, after which the party visited the church under the guidance of the rector, the Reverend E. M. Turner.

The morning session on Tuesday, September 4, was devoted to a series of papers by sixth-form school pupils. Anthony E. Hanwell (King Edward VII School, Sheffield) spoke on 'The history of science in a sixth-form science course' and gave his impressions of the place of the history of science in education and its bearing upon the training of scientists.

Kenneth R. Hughes (Chesterfield) gave an account of his observations on 'British finches', dealing with the mating and breeding customs, and reporting little essential difference between the behaviour of wild birds and those of the same species kept in aviaries.

Miss Anne Bunting (Thorne Grammar School, Doncaster) gave an account of 'Some little-known and unpublished aspects of the life history and habits of *Periplaneta americana* (L)' and suggested that under favourable conditions the incubating and growth periods were shorter than commonly supposed.

Keith L. Watson (Charterhouse) gave an account of 'The Charterhouse astronomical project'. He described the use of the observatory built about fifty years ago, outlined the history of an astronomical society formed in the school and referred to the assistance and encouragement given by a local amateur.

John K. Chesters (High Storrs Grammar School, Sheffield) gave an account of observations on 'The ecology of Porter Brook'. A statistical study was made of the animal life in a small river near Sheffield, in order to record variations with distance from the source and with the season. The results showed that the volume and rate of flow of the stream were amongst the important controlling factors.

The attendance at the session of juniors was the best that the Section enjoyed and the papers were enthusiastically received. A notable feature was the careful timing of all papers. Section X activities for the year closed with a visit in the afternoon to the Sheffield factory of Messrs. Walker and Hall Limited, where members saw the various processes involved in the manufacture of silver ware and plate of high quality.

BLOOD GROUPS AND ANTHROPOLOGY

DURING the Sheffield Meeting of the British Association, on August 31, 1956, a symposium entitled 'Blood Groups and Anthropology' was held by Section H (Anthropology and Archaeology), jointly with Sections D (Zoology) and I (Physiology). After Dr. Mourant's presidential address, 'Blood groups and human evolution' (*vide The Advancement of Science*, vol. xiii, no. 50, September 1956, p. 91) which served as an introduction, seven papers were presented. Summaries of six of these, and of the summing-up of the subsequent discussion, appear below in the order in which they were presented.

ASSOCIATIONS BETWEEN BLOOD-GROUPS AND DISEASE

By Dr. J. A. Fraser Roberts
(*London School of Hygiene and Tropical Medicine*)

It is now known that persons belonging to different blood-groups may differ substantially in their susceptibility to certain diseases of adult life. The search for associations has a long history, going back thirty-five years. A review of the literature, however, shows that prior to 1953 only one association, viz. of blood-group O and peptic ulcer, had been discovered, and that was not clearly established. The chief reason for the failure of the earlier enquiries to give positive results was that the numbers studied were too small.

In 1953 results were published (1) on more than 3,000 patients suffering from cancer of the stomach which showed that the incidence of this disease was greater by a highly significant amount in persons of group A than in those of Group O. In 1954 an even greater difference in peptic ulcer was demonstrated (2). Confirmation has come from several centres both in Great Britain and in other countries (3).

The evidence for three associations is now overwhelming. The incidence of duodenal ulcer is about 40 per cent higher in persons of group O than in those belonging to groups A, B and AB. Gastric ulcer is about 25 per cent commoner in those of group O. Cancer of the stomach is about 25 per cent higher in persons of group A than in persons of groups O and B. There is fairly strong evidence that persons of group A show an increased incidence of diabetes mellitus (5) and of pernicious anaemia (6).

Side by side with the positive results there have been negative findings for ABO in a number of other diseases, including several cancers, toxaemia of pregnancy and hypertension.

Yet another association with a simply inherited blood-group difference has been conclusively demonstrated by investigators at Liverpool. Sufferers from duodenal ulcer show a marked excess of those who do not have the AB substances in their secretions (4).

Apart from the ABO blood-groups, much work has been done on the Rhesus system, but no clear association has yet been found with any disease other than haemolytic disease of the newborn.

The first question is whether the demonstrated associations are on the one hand truly causal in the sense that, for example, a person of group O is intrinsically more likely to develop a duodenal ulcer, or whether on the other hand the associations may be secondary to racial or other stratifications in the population. If there were strains in the population characterised both by a high frequency of gene O and a raised susceptibility to duodenal ulcer, the association could then be of this secondary type. No clear answer can be given at present, but the stratification

hypothesis seems unlikely on several grounds. First, the same associations have been found at numerous centres in Great Britain, Switzerland, Norway, Denmark, Italy, Portugal and the United States, and it would be strange if similar stratifications of the population existed in all these countries. Secondly, the differences in blood-group frequencies between the presumed strata would have to be very large to account for the associations, but there is no evidence that such strata exist, though a more direct search is very desirable. On the other hand, there are the results of an investigation at Liverpool. A family study of those with duodenal ulcer has failed to produce evidence that persons of group O are more prone to the disease than their own brothers and sisters belonging to other groups. Large though the numbers are, however, they are not yet sufficient to establish this negative conclusion.

At present it seems most probable that the associations are directly causal. If so, powerful support is given to the views put forward more than twenty years ago by Fisher and Ford. Differences in ABO groups are at least as old as the human species, and the indefinite perpetuation of a polymorphism of this kind must depend on a balance of selective forces favouring the existence of a mixture of different genetic types in the population. It is a dynamic and not a static equilibrium: an equilibrium, moreover, which is liable to be changed, albeit slowly, by changes in environmental conditions.

Turning to another line of evidence, the age distributions of blood donors have been studied on a very large scale, the numbers in one or two series approaching 100,000. The ages adequately represented by blood donors range from about 18 to 60, and over this span of life no significant differences have been found in the age distributions of donors of the different blood-groups. Thus, even on very large numbers, there is no evidence that the chances of survival after the age of 18 or so differ as between individuals of the four ABO groups. It must therefore be concluded that differing susceptibilities must be very nicely balanced in terms of the advantages and disadvantages of belonging to a particular group. So far advantages have been found attaching to group O and to group A, but in each instance persons of group B go with the more favoured of these two groups. No doubt time will show what it is that persons of group B suffer from to a greater extent than others.

Whatever the explanations may ultimately prove to be, these associations are phenomena of major anthropological and medical interest. Work is proceeding very actively at many centres in different parts of the world; there is every hope that the result will provide a valuable contribution to the understanding of the workings of natural selection.

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THE GENETICS OF HUMAN MORPHOLOGICAL CHARACTERS

By Dr. J. M. Tanner and Mr. M. J. R. Healy
(*Institute of Child Health, University of London and Rothamsted Experimental Station*)

That children tend to resemble their parents in bodily size and shape is scarcely a recent discovery. Family resemblances, in detailed appearance as well as in overall size, are largely determined by heredity; it may therefore seem surprising

that, after fifty years of spectacular advance in genetical science, the detailed mode of inheritance of (say) stature is almost entirely obscure—almost nothing is known of the number of loci involved, of the dominance relations at each locus or of the linkages and interactions between them.

The reason lies in the complexity of the genetical situation involved. The ABO blood-group system divides mankind into four fairly definite classes; no such definite classes exist in the case of a morphological character, such as stature, in which instead a continuous range of values is found. Early developments of Mendelian genetics had little to contribute to the study of continuously variable characters, and it was indeed suggested that some different mode of inheritance was involved. It was Fisher's classical paper of 1918 which showed that the observed degrees of resemblance between relatives could be explained by Mendelian theory without the introduction of new concepts.

With characters depending on one or a few loci, e.g. the ABO blood-groups, where an individual can be assigned to one of a number of well defined classes, genetical conclusions are based on counts of the numbers of individuals falling into the various classes. With continuously variable characters such as stature, where no such classes exist, it is measurements on the individuals, and in particular the variability of such measurements, that are used for genetical analysis. By statistical procedures, the correlations between values for relatives may be computed and the variability can be analysed into heritable and nonheritable components.

Fisher showed that the observed correlations between relatives could be explained if stature were genetically controlled by a large number of genes, each individually producing a quite small effect. Such genes have been called *polygenes*. Although not individually identifiable, the polygenes are expected to exhibit the usual phenomena of dominance and of linkage, with each other, with major genes and with sex. Such phenomena affect the resulting correlations, and, inversely, they may be deduced from the observed pattern of correlations between relatives of different degrees.

Considerable research on characters controlled by polygenes has been carried out in plants and animals, particularly because such characters include those of economic importance studied by breeders. In man special difficulties arise because the experimental techniques used by plant and animal breeders cannot be applied. Human shape and size, although mainly genetically controlled, are affected by the environment to some extent, and in a way which mimics polygenic effects—that is to say, differences in environment give rise to a continuous range of variation between individuals. The environments during growth of a pair of brothers tend to be more alike than those of a father and his son, and this will give rise to a correlation pattern similar to that produced by genes showing dominance.

With the advance of statistical methodology, various new techniques have been introduced. Thus Fisher and Grey (5) showed that, with a character such as stature, a test for dominance could be made by fitting a relation of the form

$$y = b_0 + b_1x_1 + b_2x_2 + b_3x_1x_2$$

where y denotes offspring's stature and x_1 and x_2 the statures of the two parents. The product term measures non-additivity in the influence of the parents such as would be caused by dominance or some form of interaction between the effects of the genes concerned. The presence of dominance in the inheritance of stature is of some practical interest, since it forms the basis for Dahlberg's explanation of the secular increase in stature at the rate of about one inch per generation that has been taking place in America and western Europe over at least the past hundred years (6). Applying their technique to some data of Boas, Fisher and Grey obtained somewhat inconclusive results. We have investigated in the same way more

recent data of Durnin and Weir (2) on 246 parents and their offspring, and find $b_3 = +0{\cdot}0028 \pm 0{\cdot}0044$ for sons and $+0{\cdot}0414 \pm 0{\cdot}0347$ for daughters.

Both figures might easily have arisen by chance in the absence of any real non-additivity, and although the signs of the coefficients agree with each other and with that found by Fisher and Grey, it cannot be said that any strong evidence for dominance exists.

Finney (3) described an ingenious test for sex-linkage. If a polygene affecting stature is sex-linked, it can easily be shown that families receiving the gene from the mother will show a smaller variability than those receiving it from the father, in which only daughters will be affected. Finney applied his test to some of Galton's data and obtained inconclusive results; we have investigated Brues' (1) data on 83 families, and find no evidence for sex-linkage in genes controlling stature, but fairly conclusive evidence in the case of linearity of build as measured by height/$\sqrt[3]{}$weight. As a by-product of the same investigation, we have obtained evidence that the stature genes are to some extent sex-limited, probably in the way they affect the spurt in growth that takes place at adolescence.

For all its difficulties, genetic analysis of human size and shape is again moving forward. Where once absence of adequate techniques impeded progress, it is now the lack of up-to-date reliable data that is likely to prove an obstacle.

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THE DISTRIBUTION OF SOME HUMAN SEROLOGICAL CHARACTERS IN AFRICA

By Dr. D. F. Roberts

(Department of Human Anatomy, Oxford)

Maps of the distribution of the ABO blood-groups and the sickle-cell trait in Africa are more accurate than those of other serological characters; all are tentative estimates.

The frequency of blood-group gene A is just over 20 per cent in Bushman and Hottentot, diminishing northwards and eastwards to less than 10 per cent in pockets along the east coast. From a general level of 10–15 per cent on the East African plateau, the frequencies rise again northwards and westwards to 20–25 per cent over the northern quarter of the continent, with peak values approaching 30 per cent in northern Egypt. This fairly regular pattern is interrupted in the case of some more isolated peoples. Blood-group gene B over most of Africa remains at a fairly constant frequency of 15–20 per cent, slightly higher in the Congo pygmies and northern Egypt. Bushmen, Berbers and peoples of the eastern plateau tend to have lower frequencies.

The general African frequency of gene M lies at 45–60 per cent; highest values occur in two areas, in the north-east and among the Bushman-Hottentot, linked by a chain of local populations of high frequency. There appears to be a general diminution of frequency westwards. The frequencies of gene S of the MNS system are consistently low in southern Africa, but increase northwards to over 25 per cent in the north-east, whence a salient of higher values appears to project into East Africa.

Of the genes of the Rh system, C diminishes sharply in frequency southwards from the Mediterranean 45 per cent to a level of below 20 per cent over most of the continent south of the Sahara. The frequency of D over most of the continent is over 70 per cent, lower in the north, the eastern horn and the extreme west. The pattern shown by E departs from the well marked north–south gradients shown

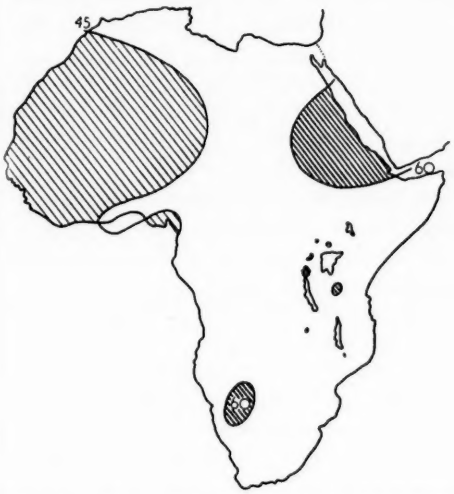

Fig. 1*a*.—African distribution of gene M (MNS blood-group system).

Fig. 1*b*.—African distribution of gene S (MNS blood-group system).

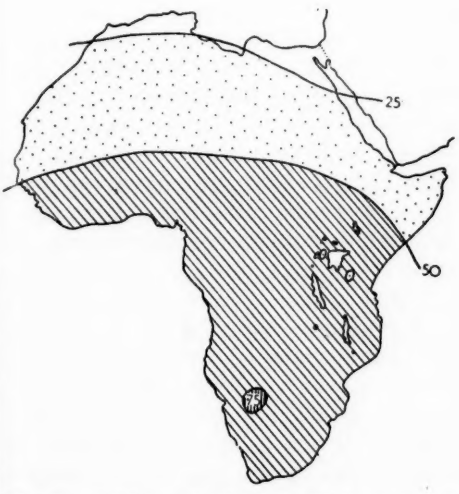

Fig. 2*a*.—African distribution of chromosome cDe (Rh blood-group system).

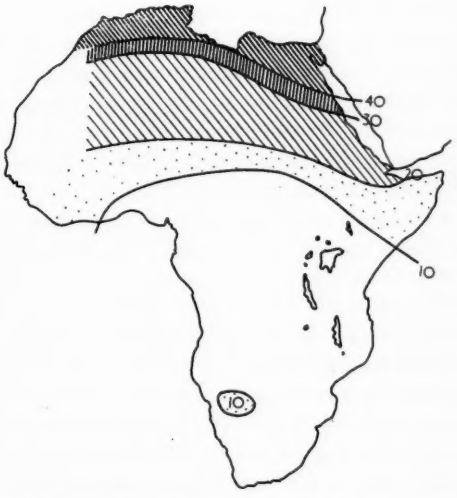

Fig. 2*b*.—African distribution of chromosome CDe (Rh blood-group system).

by C and D; only in the north and extreme east and at a focus in the centre of the continent are frequencies over 10 per cent. The estimated frequencies of the different combinations in which these genes occur also show patterns of interest. Very striking are the clines southward from the Mediterranean of chromosomes cDe (excluding cD^{u}e) and CDe, the former doubling, and the latter halving, its frequency by the time the southern border of the Sahara is reached.

Of the several abnormal haemoglobins detected in Africans, two show distribution patterns of interest. Haemoglobin C has a focus at a phenotype frequency of

over 20 per cent in the northern Gold Coast, whence the frequency diminishes in all directions. Outside West Africa it has only been found at very low frequencies, where in each case its presence can be attributed to the importation of West Africans, usually as slaves. The localisation of the trait at any appreciable frequency in West Africa suggests that it may have originated here, while its frequency seems in some way to be inversely associated with that of haemoglobin S. The complex distribution of haemoglobin S (sickle-cell haemoglobin) may be analysed in terms of three components:

(*a*) A regional component; all peoples showing the trait at any appreciable frequency are found in a broad belt bounded on the south by the Zambesi and on the north by the savanna grasslands. Within this 'sickle-cell belt', highest frequencies occur in patches in East Africa, diminishing to west, north and south.

(*b*) A local component; peoples inhabiting lower-lying, damper areas tend to have higher frequencies than their ethnically similar neighbours in dryer higher habitats; this local relationship has been adduced in support of the hypothesis that possession of the trait affords some protection against malaria.

(*c*) An ethnic component; peoples of different ethnic affinities within the same territory may possess the trait at different frequencies.

Among features common to all African populations south of the Sahara yet tested are very high frequencies of the Rh chromosome cDe and blood-group gene P, a high frequency of the Kidd gene (Jk^a), a low frequency of gene S of the MNS system, and a low frequency of the Duffy gene (Fy^a). Such features in combination demonstrate the essential genetic similarity of African peoples despite their morphological and cultural differences, and distinguish them from each of the other continental groups of man—thereby demonstrating the effectiveness of the barrier to gene flow provided by the northern transcontinental deserts in times past.

As more data become available, however, ethnically interesting local variations within the general pattern appear. In East Africa for example, the cultural distinctions between people are, broadly, supported by the ABO frequencies—the barriers to gene flow in this case being provided by cultural differences. For interpretation of these variations attention to the processes by which gene frequencies change is demanded. In many African peoples a large proportion of individuals fails to achieve adulthood; it is under these conditions that natural selection in man is likely to be observable. For studies of the selective value of different characters there is considerable scope; e.g. for comparison of the incidence of diseases in possessors of different blood-groups, for examining the association of other biological features with serological traits, for studies of differential fertility and mortality. Differences in settlement pattern and social organisation are reflected in the rate of random genetic drift, which can be calculated from detailed demographic data. Examination of genealogies would allow the more recent penetration of genes into new areas to be traced. Investigations repeated at intervals may not only permit the identification of the particular processes responsible for local differentiation of populations, but also give an idea of the rates at which changes in gene frequencies are occurring. The interpretation of differences in gene frequencies between ethnic groups awaits the results of such studies.

BLOOD-GROUPS AND ARCHAEOLOGY

By H. W. M. Hodges

(*Department of Archaeology, The Queen's University, Belfast*)

Correlations to be made between archaeological and blood-group data appear to be of two distinct types: the study of blood-groups of archaeological specimens—mummified bodies and skeletons—and the comparative study of distribution

patterns of present-day blood-groups and certain classes of archaeological material.

The pioneers in the determination of blood-groups of mummified muscle tissue, L. and W. C. Boyd, in the last quarter of a century have reported on some 300 mummified bodies—chiefly Egyptian and American Indian. Although it is obviously difficult to find adequate methods of control, the results of these investigations have been remarkably consistent, and indeed conform to what might have been expected from modern blood-group distributions.

This method is of limited application since mummified bodies are an archaeological rarity. Twenty years ago, however, Candela published the first results obtained by testing ground bone samples from skeletons. As in the case of muscle tissue, the most obvious difficulty in this technique is that of finding suitable controls; but it should be pointed out that, working on a group of Aleutian mummies, Candela obtained more clear-cut results from the bone samples than from the muscle tissue.

It seems hardly necessary to point out how important this work could be to archaeologist and anthropologist alike; but its value will depend not only on the accuracy with which the determinations are made, but also on their numbers. So far, there are too few results from any given area and horizon for adequate statistical analysis. From Europe there are none at all; but this, it is hoped, will soon be remedied.

The second aspect of study—the attempted correlation of archaeological material with the present-day blood-groups—is, in my opinion, of very doubtful value in the present state of our knowledge. Thus, the view has recently been advanced that the Polynesian people of the Pacific Islands derived as the result of migration from America rather than more directly from Asia. In support of this theory similarities in material equipment have been noted in Polynesia and the American continent, as well as a likeness of the blood-group components amongst the peoples of the two areas. But these similarities, although suggesting connections between the two peoples, do not give any hint as to the direction of migration. For that, reliance has been placed on the legends of the Polynesian people. Similarly, there is the legend that the Etruscans originally migrated by sea from Asia Minor, and, although the archaeological evidence is inconclusive on this point, the likeness of blood-group composition amongst the present-day inhabitants of North Italy and those of the Mediterranean seaboard of Turkey has recently been cited as evidence of this migration.

In both these cases the testimony of present-day blood-groups has been sought, after—or perhaps because—the archaeological evidence has failed. At the best these blood-group similarities can only give credence to the legend, which is far from establishing an historical fact. This is not to deny that blood-groups used in this way give a valuable working hypothesis, but we must never lose sight of the fact that this is all that it can ever amount to, unless blood-group proportions can be shown to remain stable over exceptionally long periods.

Archaeological data have similarly been used occasionally in an attempt to explain some abnormal feature of modern blood-group distribution. There is of course no need for archaeological material to have any bearing on the subject of race whatever. Even so, most archaeologists believe that certain groups of material do in fact reflect the racial affinity of the users, specifically early hand-built pottery, and burial monuments. But the truth of the matter is that the somewhat clumsy process of synthesising history from archaeological material is not sensitive enough to detect racial mixture in invasion or folk migration. It may fairly be said that the general blood-group distribution pattern in the British Isles reflects the distinction between Anglo-Saxon and Danish south and east, and the British (or Celtic speaking) north and west; yet archaeologists are at variance on the question of Celtic

survival in Anglo-Saxon England, and it would seem inadvisable purely on archaeological evidence to go beyond this generalisation. Further back in prehistory the use of archaeological data in this respect is yet more unreliable.

If we are to advance at all in this approach we have first to cover a great deal of preliminary groundwork. In the first place we need to satisfy ourselves as to the stability of blood-group frequencies over long periods. This, I believe, could be done if an attempt were made to group skeletal material of, say, the seventeenth century—as, for example, from some of our better vaulted graves—and from there to work systematically back in time. This, of course, means not only the grouping of bone specimens, but also the grouping of large numbers. As Mourant has pointed out, it is not the kind of work that can successfully be carried out as a spare-time activity by someone normally engaged in grouping for transfusion purposes. Ideally it should be done by a research unit comprising both anthropologists and archaeologists, in order that the blood-group, anthropometric and archaeological data may be set side by side. It is only in this way, I think, that we shall be able to put the joint study of archaeology and blood-groups on a sound footing.

BLOOD GROUPS IN RUMINANTS AND HUMAN MIGRATION

By J. V. Evans
(*Rowett Research Institute*)

The intimate ecological association between human groups and their domestic animals may enable us to trace human migrations by a study of gene frequencies in animal breeds. Genetically controlled differences in a number of characters between individual sheep of the same breed have recently been brought to light. In this paper differences in the potassium concentration, and the type of haemoglobin present, in the red blood cells will be considered.

The Scottish Blackface breed, for example, can be divided into two distinct types of animal by the concentrations in their red blood cells of potassium and sodium (1). One type has much more potassium than sodium, while the other has much more sodium than potassium. Fortunately these two types can be recognised when whole blood is examined and this means that large numbers of animals can be investigated at one time. Not only do these two types of sheep exist side by side in the Scottish Blackface breed but it has been possible to show that the ratio of high potassium (HK) to low potassium (LK) animals in this breed is not the same as it is in the Cheviot breed.

This has led to a study of the genetics of these two types of animals in British breeds of sheep. It has been shown that these characters are simply inherited and that HK is the recessive (2). The genetic nature of the phenomenon suggested that the HK/LK ratio might be different in all breeds. A survey of sixteen British breeds showed that this was so, e.g. the Rough Fell had 73 per cent of HK animals, English Leicester no HK animals (4), and all other breeds fell between these two extremes. Mountain and hill breeds had higher percentages of HK animals than lowland breeds. This suggests that natural selection may possibly be partly responsible for the differences.

Outside the British Isles it has been possible to show that Icelandic, Norwegian and Finnish sheep have very high percentages of HK animals (approaching 100 per cent) and that Middle East and African breeds, although they may be slightly different from the breeds of northern latitudes, are also predominantly HK. There are two notable exceptions, however; the Merino of Spain consists almost entirely of LK animals, and the Barki of Libya has only 19 per cent of HK types.

If the results from the British breeds and the overseas breeds are represented on

maps (Figs. 3 and 4) the impression is given that LK sheep may have been brought from Iberia to the south-west of England and this in turn suggests a possible association of present-day sheep red blood cell characters with megalithic remains in this country.

Another difference among sheep of the same breed lies in the type of haemoglobin present in the red blood cells (5). It has been possible to show that these

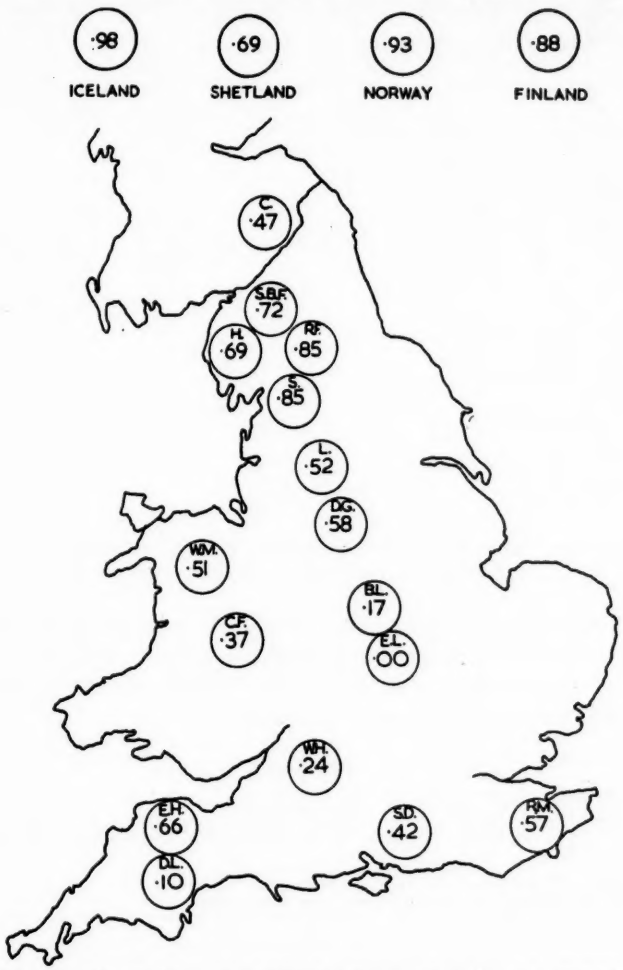

Fig. 3.—Distribution of red blood cell potassium types in British breeds of sheep. The frequency of the recessive (high potassium) gene is shown. Abbreviations used are as follows: *B.L.* Border Leicester, *C.* Cheviot, *C.F.* Clun Forest, *D.G.* Derbyshire Gritstone, *D.L.* Devon Longwool, *E.L.* English Leicester, *E.H.* Exmoor Horn, *H.* Herdwick, *L.* Lonk, *R.F.* Rough Fell, *R.M.* Romney Marsh, *S.B.F.* Scottish Blackface, *S.D.* Southdown, *S.* Swaledale, *W.M.* Welsh Mountain, *W.H.* Wiltshire Horn.

haemoglobin types are also simply inherited (3) and that a physiological correlation between them and the potassium types exists.

A marked difference in the frequency of the gene responsible for B haemoglobin can be shown between British breeds of sheep. It is remarkable that the frequency for B in Africa and the Middle East is almost 1·00, while in northern European breeds it is almost zero. It is of interest that the two Canadian Bighorn sheep which have been examined to date were HK and type B haemoglobin.

Differences between breeds of sheep have been demonstrated in the specific gravity and dry matter percentage of the red blood cells and the plasma. Different red blood cell potassium types have been found in the goat as well as the sheep, but not as yet in cattle.

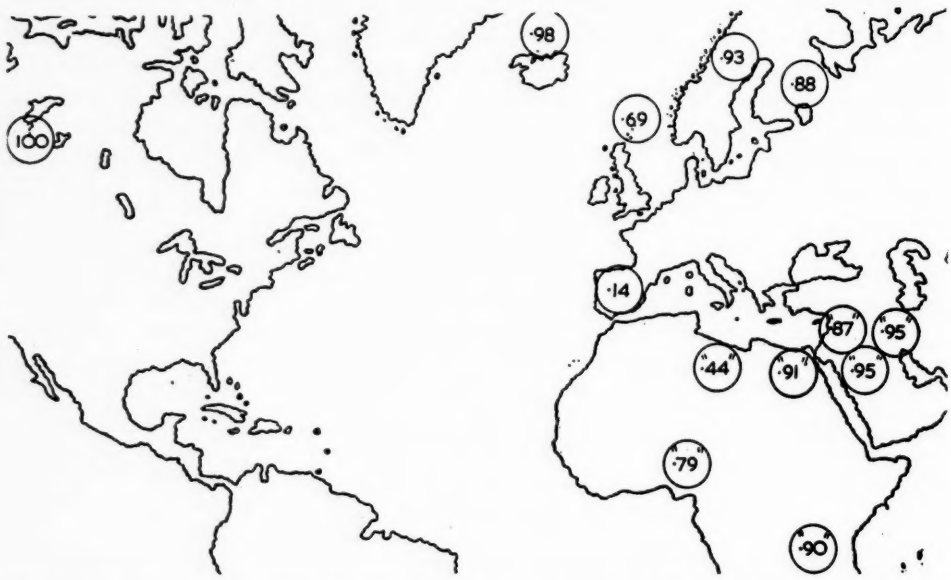

Fig. 4.—Distribution of red blood cell potassium types in northern European and African breeds of sheep. The frequency of the recessive (high potassium) gene is shown.

As man and the ruminants have been ecologically associated for many thousands of years it is possible to consider the present-day distribution of the red blood cell differences in sheep in relation to the migratory movements of this species, and therefore in relation to the movements of mankind.

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BLOOD-GROUPS IN GREAT BRITAIN

By Dr. Ada C. Kopeć
(*Nuffield Blood Group Centre*)

The survey of the ABO blood group distribution in this country, at present being carried out by the Nuffield Blood Group Centre, now includes the results of tests on more than 160,000 persons. An earlier paper (6) reported on the findings on some 38,000 of these. From the numbers of observations now available it is clear that the ABO distribution is not homogeneous and that its variations are discontinuous rather than gradual.

The country is divided into thirteen regions (Fig. 5) by the application of the ratios, used by Dr. Fraser Roberts, $\frac{A}{O+A}$ and $\frac{B+AB}{O+A+B+AB}$. Each area is homogeneous with regard to both ratios, and each differs significantly from the

REGION	NUMBER	O	A	B	AB
I	9,277	4,940	3,038	1,015	284
II	17,455	8,917	6,257	1,791	490
III	6,395	3,103	2,554	530	208
IV	1,529	692	657	128	52
V	6,344	2,990	2,663	520	171
VI	4,131	2,076	1,638	320	97
VII	9,301	4,633	3,575	841	252
VIII	7,018	3,271	2,821	700	226
IX	42,179	19,632	17,815	3,415	1,317
X	16,641	7,287	7,545	1,282	527
XI	31,790	14,280	14,017	2,543	950
XII	7,010	3,290	2,961	550	209
XIII	2,303	962	1,071	184	86
TOTAL	161,373				

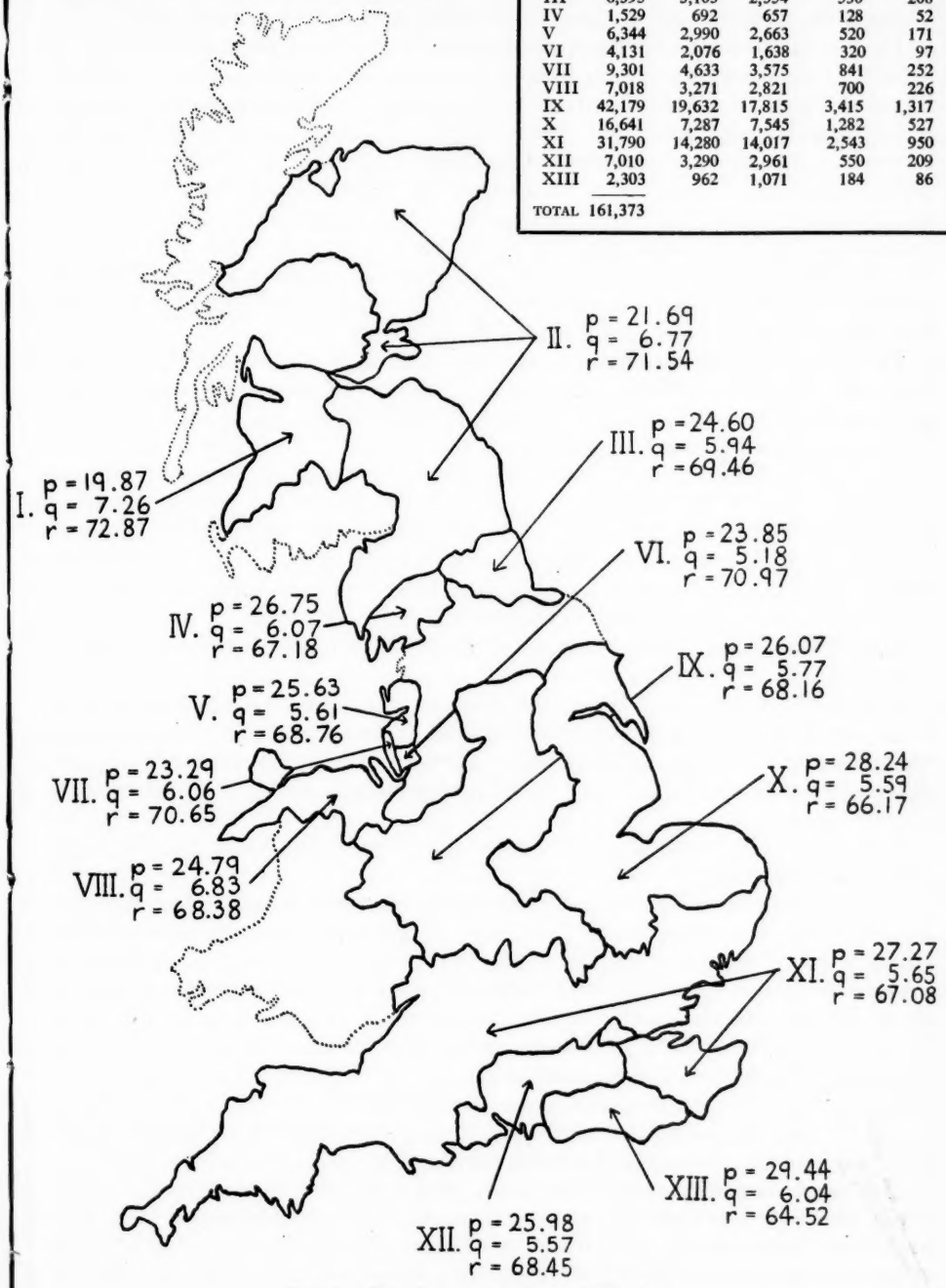

Fig. 5.—Blood-group regions of Britain.

adjoining ones with regard to at least one if not both ratios. Numbers for the particular regions are generally large enough to ensure a sufficient representativeness of the samples and comparisons of successive batches of data from the same district have confirmed their homogeneity. These two conditions have failed to be satisfied

simultaneously for only two areas, and for these we should like to see the frequencies confirmed—in region IV (Westmoreland and the Furness district of Lancashire) the number of observations is relatively small and in region XIII (Sussex) the distributions in successive batches have been less consistent.

The variations in the frequencies of genes O and A are largely reciprocal. The highest O frequencies occur in Scotland and the two most northerly counties of England (regions I and II). Within Scotland, however, the O frequency in region I is still significantly higher. In region III the O frequency is already markedly lower, but it remains nevertheless higher than in all more southerly regions (with the exception of a small part of Lancashire). In region IV, on the other hand, the distribution we find (yet to be confirmed by larger numbers) is almost the same as that quoted by Prof. Fisher and Dr. Taylor for southern England. Region V has a very similar distribution to region IX and only the southern strip of Lancashire (regions VI and VII) has a markedly higher O frequency (the highest in England with the exception of the part included in region II).

The part of Cheshire covered by our data (the Wirral peninsula) has a lower O frequency than North Wales, but, on our numbers, the difference is not yet significant and the two are joined in region VIII. The difference in O/A distribution between regions IX and X appears to be quite genuine for it is very highly significant. The dividing line cuts across two counties: the East Riding of Yorkshire, the eastern part of the West Riding (with Selby, Goole and Doncaster) and the northern part of Northamptonshire belong clearly to the area with the most consistently high A frequencies. The A and O frequencies previously considered typical for southern England have actually been found to apply to most of that area (region XI). The interesting exception is region XII (Surrey and Hampshire) where the frequencies now seem to be of the kind previously thought to be typically 'northern'.

The distribution of gene B is much more regular. The markedly higher 'Celtic' B frequency is found in Scotland and North Wales; Cumberland and Northumberland have a B frequency intermediate between the Scottish and English (neither difference being significant) and the Wirral peninsula has a B about as high as North Wales.

Prof. H. J. Fleure has suggested from the present data some possible anthropological correlations.

In area I, where we have found a higher O incidence than in the rest of Scotland for which we have data, nearly two-thirds of the total observations are from the Glasgow postal district. This district contains a great number of urbanised Highlanders (from the West Highlands) and West Irish. O phenotype frequencies of about 59 per cent are quoted by Dr. Kirkpatrick for eastern Ross and western Inverness and Dr. Hackett gives even higher ones for some of the western counties of Ireland. The higher A incidence in region IV, if confirmed, may reflect the many links of Furness with the Dano-Norse city of Dublin. The high O frequency in region VI may be due to the large Irish immigration of about 100 years ago, and in region VII (Liverpool) to the many Irish and Welsh now working there.

The Anglo-Saxons coming from north-west Germany, Schleswig-Holstein and Frisia may have had high A frequencies: Buchner quotes over 50 per cent for East Friesland, Gundel nearly 47 per cent for Oldenburg and over 50 per cent for many of his samples from Schleswig-Holstein. The survival of high A frequencies would be more probable in areas where they had come with their own women as settlers rather than as military conquerors, because villages founded by them would be to a great extent endogenous. Very early cemeteries with evidence of cremation, especially when in close-set groups, indicate the existence of such villages and they are a feature of the East Riding of Yorkshire, Norfolk, Cambridgeshire, north Northamptonshire and Leicestershire, where the A percentage is high. For the Solent

and Hampshire, on the other hand, there are many indications of warlike invasion and struggle. Warrior bands would be predominantly male and take native girls, which might explain the stronger persistence of O blood there.

It can be seen from the map that data are still lacking for some areas; for others numbers are not sufficient to give reliable results. Only when blood-group frequencies have been determined with certainty for all parts of the country will it really become possible to attempt an explanation of the distribution then established. Meanwhile, Prof. Fleure's comments have been put forward as tentative suggestions, in the implications of which there is much food for thought.

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SUMMING UP OF THE SYMPOSIUM

By Dr. N. A. Barnicot
(University College, London)

Renewed interest in natural selection and the effects it may have on the distribution of genes in human populations is reflected in this meeting. Dr. Fraser Roberts has reviewed various recent studies which show an association between ABO blood-groups and certain diseases. It is not yet clear whether these associations indicate a direct relation of these particular genes to disease susceptibility. Continuation of such work may show that disease can be a selective agency acting to change blood-group gene frequencies, which may then appear less static than was formerly thought.

The inherited variants of haemoglobin, particularly sickle-cell haemoglobin, excite great interest at present, since in the case of the latter there is good evidence that the possession of one sickle gene gives some resistance to subtertian malaria. The world distribution of the gene is on the whole consistent with this idea, and in interpreting this distribution we may be led astray if we think only in terms of population mixture and movement and neglect environmental differences in malaria transmission.

The work on haemoglobin variants also illustrates the value of biochemical methods in revealing hitherto unsuspected genetical variation. Mr. Evans has told us of other types of biochemical variation of red blood cells which occur in sheep.

It has been suggested that the chance fluctuations of gene frequency which occur if a population is small enough may have been important in producing diversity in man. Dr. Roberts has investigated certain tribes in the Sudan to see if this effect is likely to have occurred in them. There is a need for more demographic data on primitive peoples, which social anthropologists could help to collect, if the best use is to be made of genetical theory.

Although changes due to selection and genetic drift may make it difficult in some instances to draw conclusions about the more remote origins of populations from genetical data, historical and archaeological evidence will always need to be considered in such attempts. Dr. Kopeć has related the impressive mass of recent ABO blood-group data for the British Isles to evidence of this kind. Mr. Hodges

has warned us of the limitations of archaeological evidence; cultural changes which it indicates may not necessarily be accompanied by significant biological changes.

Attributes such as body measurements are considered to depend on the effects of many genes which are not individually identifiable, so that outward similarities may conceal hidden genetical diversity. Dr. Healy has outlined some of the methods which have been developed to study the inheritance of such characters, but there is still far to go before analysis of these traits can approach the precision which makes the blood-groups and certain other simply inherited characters so useful in population genetics and anthropology.

THE FUNCTIONS OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

1. THE BRITISH ASSOCIATION remains unique as an independent institution of national reputation, which brings almost the whole range of sciences within its scope and opens its membership to all who are interested in the progress of science. Founded in 1831 to convince an indifferent public and government that science was important and worth backing, the Association—as its history bears witness—succeeded magnificently in its original purposes. Today science is of paramount importance to the country and, although the Association can no longer hope to finance major research projects or to provide a platform for the immediate proclamation of scientific discoveries, other urgent tasks present themselves.

2. 'Science' has brought into being a new world, in which the peace and prosperity of all peoples are increasingly dependent the one on the other—dependent because the units of organisation (social, economic, political and national) are larger and their control more centralised; a world whose structure is in this sense more rigid and yet one in which both individuals and nations must respond more flexibly and more frequently to the changing situations forced on them by the discoveries and applications of science. The continuance of science is vital to modern society, and this being so, continued public goodwill is essential. To ensure this the methods and results of science and the nature of fundamental research must all be better understood by those concerned with government, industry and business and the public at large. Such understanding is essential because in any democratic state an informed public is necessary if valid decisions are to be taken; because the public —as taxpayer and consumer—pays for science; because if, in the future, scientists and technologists are to be forthcoming in the numbers that the nation's wellbeing demands, the public should learn to value the contribution of science and come to appreciate the potential satisfaction and opportunity for service implicit in careers devoted to science; and above all because scientific discovery must be applied for the wellbeing of the nation.

3. How then can the British Association contribute to this end? At present its main opportunity for service lies in the great Annual Meetings which are attended by representatives from every branch of science; by industrialists, government servants, agriculturalists and many who are interested and involved in the applications of science; by teachers, representatives of the press, radio and television (and indirectly and invisibly by *their* own audiences); by laymen interested in the progress of science and its social implications. It will perhaps be timely, therefore, to attempt to re-define the objectives of the Annual Meetings.

The Association is of the opinion that the Meeting should, broadly speaking, attempt to do three things. First, to offer a platform on which leading scientists can discuss their work in all its theoretical complexity—for fundamental work is not only at the heart of all progress in science but it is also important to demonstrate the 'compulsion of facts' and the 'dignity of expertness' and to give the public an understanding of the integrity and discipline involved in the search for scientific 'truth'. Secondly—for such is the specialisation and fragmentation of science—to encourage scientists to discuss in joint sessions problems in related fields and to develop common problems involved in subjects on the frontiers of present knowledge. For if communication between scientists is limited, the advance of science is

[1] Interim Report of a committee appointed to consider, under the chairmanship of Sir Ben Lockspeiser K.C.B., F.R.S., the functions of the British Association in the world today.

retarded; and new outlooks and avenues of enquiry may emerge from such juxtaposition of the work of different specialists. Thirdly, to provide for non-specialists—whether they be scientists outside their own field or interested laymen—an annual stocktaking in intelligible language which will review the progress of science and help to make clear its significance and possible consequences. It is imperative that scientists and laymen should be seen to accept the need to foresee and debate the social and political consequences of science. Prominent industrialists and political leaders should be invited to contribute to such sessions in order to put the problems in their wider setting. Such discussions should also serve to make it clear that modes of thought, other than the scientific one, must contribute to the solutions of situations arising out of scientific discovery.

4. If, to summarise, the overriding purposes of the Association are conceived to be discussion, integration and dissemination, then it is obviously desirable that somewhat more 'conscious' planning of its meetings should be undertaken. It is proposed, therefore, to set up a Programme Committee which will supplement the invaluable and essential contribution of the Section Committees and will attempt to ensure a balanced programme for the meeting as a whole. But the Association cannot work entirely on its own. It is aware of the major contribution which the Press of this country has made and is continuing to make, not only to the success of the Association's work, but also to developing and encouraging public interest in science. Without the support of the press the Association cannot hope wholly to succeed in its tasks. It is firmly of the opinion, however, that much more remains to be done in consultation with the press, radio and television authorities to make more effective public use of the mass media of communication.

5. The Annual Meeting, however, lasts for one week a year only, and the Association is conscious that to give continuity to its efforts other forms of service are necessary. It believes, for example, that there is a need for the publication of a suitably planned and presented non-specialist scientific Journal; for the holding of special one-day meetings on specific subjects, to offer industrialists and others an opportunity to discuss their problems on a platform common to themselves and to the Country's leading scientists and administrators.

In this desire to develop its public services, the Association finds itself seriously handicapped by lack of funds. To undertake additional tasks of the sort suggested is beyond the present resources of the Association with its small permanent staff. The Association has in the past been able to keep its working expenses at a low level, but only because the generous hospitality offered by cities has provided a large part of the cost of its Annual Meetings and because it has been loyally and generously served by a large number of unpaid officers. The Association feels that it has a continuing contribution to make to the life of the nation, and intends, when possible, to implement its declared aims in some of the ways suggested above.

SEISMOLOGICAL INVESTIGATIONS

SIXTY-FIRST ANNUAL REPORT of the COMMITTEE on Seismological Investigations. (Dr. R. STONELEY, F.R.S., *Chairman*, Mr. E. TILLOTSON, *Secretary*, Mr. E. F. BAXTER, Miss E. F. BELLAMY, Prof. P. G. H. BOSWELL, O.B.E., F.R.S., Mr. B. C. BROWNE, Sir E. C. BULLARD, F.R.S., Dr. K. F. CHACKETT, Dr. G. E. R. DEACON, C.B.E., F.R.S., Dr. A. T. J. DOLLAR, Dr. A. E. M. GEDDES, O.B.E., Prof. G. R. GOLDSBROUGH, C.B.E., F.R.S., Dr. M. N. HILL, Mr. J. S. HUGHES, Prof. Sir H. JEFFREYS, F.R.S., Dr. E. R. LAPWOOD, Rev. C. REY, S.J., Dr. G. D. ROBINSON, Mr. H. V. SHAW, and Sir FRANK E. SMITH, G.C.B., G.B.E., F.R.S.)

The committee records with deep regret the loss by death of two of its valued members during the year: Dr. A. W. Lee and Dr. A. O. Rankine, O.B.E., F.R.S. Dr. A. W. Lee will be remembered for his long association with Kew Observatory and seismology there, for his work on microseisms and for his revision of the late Dr. John Milne's book on earthquakes. Dr. A. O. Rankine was a physicist generally interested in seismology, especially in applied seismology, and holding many important official and industrial positions, was able to assist the committee with most valuable advice. Both gave of their best to the work of the committee.

The chairman, Dr. R. Stoneley, F.R.S., has been in the U.S.A. since August 1955. He has visited many observatories, institutions and individual seismologists whilst in America, and has attended meetings of the Seismological Society of America and other conferences. He sails for England on August 31. In welcoming him home with his enriched experience, we look forward to having again his most valued guidance.

THE GRAY-MILNE FUND

During the year the driving clock of the Milne-Shaw seismograph at Suva has been replaced; the cost of the new clock has been met out of the Gray-Milne Fund. The sum of £500 has been paid from the Crombie bequest towards the construction of a Crombie Seismological Laboratory at the Department of Geodesy and Geophysics, Madingley Rise, Cambridge. Of the Crombie bequest there remains the sum of £500 which is still deposited with the Treasurer of the Association. The sum of £400, part of the Fund's accumulated balance is still invested in Defence Bonds and it is intended shortly to increase further the amount of the balance invested.

GRAY-MILNE FUND

Receipts

	£	s.	d.
Balance, July 21, 1955	609	10	9
Trust Income	80	14	10
Interest on Defence Bonds	10	0	0
	700	5	7

Payments

	£	s.	d.
Secretarial Expenses	24	4	8
Repairs to Suva Seismograph	31	18	3
Balance at Bank	644	2	8
	700	5	7

INSTRUMENTS

There has been no change in the location of the instruments belonging to the committee during the past year. A new driving clock for the Milne-Shaw seismograph number 63 at Suva, Fiji, has been dispatched by the makers. A new driving clock is required for the Milne-Shaw seismograph number 6 at Hermanus, South Africa. The instruments are located as follows:

No. 1. Science Museum, South Kensington.
„ 3. Edinburgh.
„ 4. Downe, Kent (in storage).
„ 6. Hermanus, South Africa.
„ 27. Perth, Western Australia.
„ 63. Suva, Fiji.
Jagger Shock Recorder at Fort Augustus.

THE SEISMOGRAPH STATION OF THE MAGNETIC OBSERVATORY, HERMANUS

By Mr. A. M. van Wijk, Officer-in-charge

On the suggestion of Dr. A. L. Hales, then Professor of Applied Mathematics at the University of Cape Town, the two Milne-Shaw seismographs which had previously been in operation in Cape Town were transferred to the Magnetic Observatory, Hermanus, in 1950. In accordance with their ownership at that time, the instruments will hereinafter be referred to as the B.A. and U.C.T. seismographs respectively.

As regards the history of these instruments, it appears from the Annual Reports of the Cape Observatory that the B.A. instrument replaced the earlier Milne seismograph at that Observatory in 1920. As the cellar in which the former instrument had been mounted was found to be unsuitable, a new building was erected in that year. On account of the 'troublesome microseisms' the records were discontinued in 1931. The Department of Applied Mathematics, University of Cape Town, then took charge of the seismograph and in 1934 purchased a new instrument of the same type to supplement the records of the B.A. seismograph. The new seismograph station was located in the basement of the Mathematics Block, and gave valuable service until 1947 when the records were once more discontinued.

In 1950 both the B.A. and U.C.T. seismographs found a new home in the Magnetic Observatory, Hermanus. The instruments are mounted in the N.–S. and E.–W. directions on piers, which are isolated from the floor and from the surrounding soil to a depth of three feet. In 1956 the University of Cape Town decided to transfer the ownership of its seismograph to the Magnetic Observatory. The recording units of both instruments are in urgent need of replacement. The British Association Seismological Committee has undertaken to supply a new driving clock for its seismograph and a second clock is on order for the U.C.T. instrument.

Of the 140 or so earthquakes recorded annually at Hermanus, roughly one-third show well-defined phases. The low percentage of readable records is due almost entirely to the incidence of microseisms, which are of two main types: short-period oscillations in the range 2–8 sec., and long waves of period $\frac{1}{2}$–2 min. The latter, which are predominantly nocturnal in character, have often been noticed to coincide with the passage of a cold front over the Western Cape, and appear to be in some way associated with wave action (period 1–10 min.) of the type recorded in Table Bay Harbour. A possible reason for the absence of these long-period waves on the earlier Cape Town seismograms is that the instruments were situated three miles from the coast, compared to half a mile at Hermanus.

THE INTERNATIONAL SEISMOLOGICAL SUMMARY

By J. S. Hughes

The International Seismological Summary is accommodated at Kew Observatory by courtesy of the Meteorological Office and the Superintendent of the Observatory. The work is being carried on by Mr. J. Wavish and Mrs. Sanders; help has been given for several months by Mr. M. N. Pearson, who will be leaving at the end of July. A little external assistance is available with the copying out of observations and such parts of the work which can be done out of touch with the main organisation.

The Summary has now been distributed as far as June 1948. The next three months are in the printers' hands already, and preparatory work for the remainder of the year is well in hand. Our authorised quota for the financial year ending with October includes these parts, so in spite of short staff we should fulfil our obligations.

It would appear that the heavy work comprised in the middle of the year 1948, and the latter part, is not maintained and apparently 1949 will be less exacting. There continues to be a good deal of material which from its local nature, or its insufficiency, appears not suitable for detailed determination. This is included either with details of the instrumental readings or as a mention in the general notes.

SURVEY OF MICROSEISMS RECORDED AT ABERDEEN DURING 1955, TOGETHER WITH A REVIEW OF THE METEOROLOGICAL CONDITIONS UNDER WHICH THEY MAY HAVE ARISEN

Abstract by Dr. A. E. M. Geddes, O.B.E.

It has been suggested that microseisms are due to standing waves in the ocean caused by reflection from a steep rocky coast or by a mixture of waves in a fast moving storm. Observations at Aberdeen seemed to show that microseisms arose when neither of these conditions holds. Consequently, a survey of the records for 1955 was carried out, and a comparison made with the meteorological conditions prevailing at the time. One feature rather noticeable on the weather charts was the frequent occurrence of pressure distributions with two centres. As the occasions on which fast moving storms occurred, or cases of reflection from rocky coasts were rare, there seemed to be certain reasons for thinking that the standing waves required, arose from the interference of two sets of wave systems generated by the double low-pressure centres. Further, single low centres off either the Norwegian coast, or the American coast, produced very little effect at Aberdeen. The main regions where such microseisms are produced appear to be in the Atlantic north of 50° N., and off the rocky coast of north-west Scotland.

From a comparison of the displacements on the E.–W. and N.–S. records there is some support for the hypothesis that microseisms are due to a mixture of Rayleigh waves and Love waves.

THE DEPARTMENT OF GEODESY AND GEOPHYSICS, CAMBRIDGE UNIVERSITY

Director: *Mr. B. C. Browne*

(1) *Report from Dr. R. Stoneley, F.R.S.*

During his absence on sabbatical leave as Visiting Professor in Geophysics, the American University, Washington, D.C., Dr. Stoneley has continued his researches on elastic surface waves. This work was made possible by a grant from the Office of Naval Research and the granting of Guest Worker status by the National Bureau of Standards.

Using the values of wave velocity c in Rayleigh waves as a function of wave length $2\pi/k$, already calculated at Cambridge by the use of EDSAC, the relative amplitudes at twelve different depths in a two-layer continent have been determined for each of the fifty-seven pairs of values of (c,k). The numerical work involved is heavy, and was programmed and coded for the SEAC electronic computer at the Bureau of Standards by Dr. U. Hochstrasser. The results show the variation of the ratio of vertical to horizontal displacement at the free surface as a function of k, and are of some interest in connection with the dependence of surface amplitude on focal depth.

The mathematical part of an investigation of the propagation of Rayleigh waves across an ocean floor with a double surface layer has been accepted for publication by the Seismological Society of America. The solution of the eleven-row determinantal equation for c as a function of k covering a likely range of oceanic structures has been carried out on the SEAC by Dr. Hochstrasser, and these results are being applied to observed dispersion curves.

Dr. Stoneley has also discussed the hydrodynamical features of the motion of a turbidity current, such as that held responsible by Bruce Heezen and Maurice Ewing for the fracture of submarine cables following the earthquake off Grand Banks, Newfoundland. The difficulty of accepting Kuenen's estimate of 250 m. as the order of thickness of the current is mitigated if the current is much thinner, say of a depth of 5 m. Similar considerations apply to the cable breaks that followed the Algiers earthquake of 1954, where the epicentre was on land.

(2) *Dr. M. N. Hill's Report*

During the past year the long-period seismograph has been running in the basement of Madingley Rise. In this position it has been possible to maintain it with a period of 75 sec., but the building has proved unsatisfactory for operating the seismograph at longer periods. For this reason it was decided to build a small vault, and a grant was obtained from the Crombie Bequest to assist in this. Further money has been forthcoming from other sources which is going to allow construction of a full-scale underground vault and surface seismological laboratory. Building will commence during the summer. Apart from the long-period seismograph, the vault will contain three-component short-period Benioff seismographs. Money is available for a full-time assistant to run the station.

During July and August an expedition of six weeks' duration to the North-East Atlantic was undertaken. Extensive investigations at sea were made with new seismic equipment and the data obtained are now being processed.

High-pressure apparatus for measuring the elastic properties of rocks at 6,000 atmospheres has been completed. No systematic experiments with this apparatus have yet been started.

DURHAM UNIVERSITY SEISMOLOGICAL OBSERVATORY

By Mr. E. F. Baxter

The Wilson-Lamison vertical seismometer and G.E. galvanometer have arrived at Durham Observatory but cannot be erected until the water which seeps between the pillar and floor of the underground chamber is sealed off. A scheme to do this should be finished in August.

Readings of seismograms for three British earth tremors have been provisionally reduced:

(1) *The Leicestershire–Derbyshire Earthquake of* 1956 (*Jan.* 10)

This earthquake occurred at a little after 08 hrs., when seismograms of all the stations in the British Isles were showing much microseismic disturbance. As a consequence the readings are not very definite and the location not very precise.

The following readings have been used to locate the epicentre.

		G.M.T.
Bidston	Pn	08.12.18
Kew	PnZ	08.12.21
Durham	PnNE	08.12.34

Assuming these are correct identifications, and taking the Pn velocity to be 8km./sec., these give the epicentre at about 52° 45′ N., 01° 30′ W., which is near Ashby de la Zouch on the boundary of Leicestershire and Derbyshire. The time of origin would be about 08.11.56 G.M.T., depending on the depth of focus. This position and time gives the following differences between observed and calculated (O–C) figures.

	(O–C) sec.	*Distance (km.)*
Bidston	+ 1	130
Kew	0	160
Durham	+ 2	250
Rathfarnham (Dublin)	−10	330
Edinburgh	− 5	360

It leaves many other readings, particularly earlier readings at Bidston and Durham, unidentified. It may have been a multiple shock, or this may just be a result of the difficulty of reading the seismograms, with the large amount of background disturbance.

(2) *Earthquake of May* 4, 23 *hrs.*

A preliminary determination of the time of origin and epicentre has been made by Kew from their readings, and from Paris readings. It is 23.25.50 G.M.T.; 52·1° N., 01·6° E., which is just off the coast east of Ipswich. The readings to date are as follow:

Station	*Distance*	*Readings*	*O–C sec.*
Kew	1·3°	Pn 23.26.14	− 1
		Pg 23.26.15	− 1
		Sg 23.26.31	− 3
		Sn 23.26.37	+ 3
Durham	3·3°	Pg 23.26.57	+ 1
		Sg 23.27.05	− 4
Paris	3·4°	Pg 23.26.56	− 2
		Sg 23.27.45	+ 3
Rathfarnham	4·9°	Pg 23.27.38	+11
		Sn 23.28.05	0
		Sg 23.28.35	0
Uppsala	11·8°	P 23.28.41	− 2

(3) *Earthquake of July* 9, 01 *hrs.*

The Durham readings do not fit in at all and so that leaves the local reports which are spread over a wide area (Kelsall and Blacon, near Chester, Woolstanwood, near Crewe, and Elton, Derbyshire), and the Bidston reading, with the uncertain timing (minute-mark mechanism out of order temporarily, but hour-marking satisfactory) and the Rathfarnham readings. These accord with an epi-

centre about 53° 10′ N., 02° 55′ W., which is about four miles south of Chester, with time of origin 01.01.33.

Bidston	Pg 01.01.37	0·2°
Rathfarnham	Pn 01.02.09	2·1°
	Sn 01.02.34	

But all this rests on inadequate data.

This provisional epicentre is on the line of the NE. extension of the Bala fault, which is a major fault.

OTHER BRITISH EARTH TREMORS

By E. Tillotson

1. Minor tremors occurred at Elton, one mile west of Winster, in Derbyshire, at 01.05 hrs. and again at 03.00 hrs. G.M.T., approximately, on Monday, July 9, 1956. The first caused articles to move on a dressing table.

2. Earth tremors in Argyll are being investigated. These occurred at 21.40 hrs. on July 28, 1956, at 13.40 hrs. on August 5, 1956, and at 16.30 hrs. on August 23, 1956 (all G.M.T. and approximate). The epicentral area was near Tarbert. The Rev. Dr. R. E. Ingram, S.J., states that a near shock appears to have been registered on the seismograms obtained at Rathfarnham Castle, near Dublin, on August 23, 1956, at 16.32.04 G.M.T. There was nothing on the Bidston (Birkenhead, Liverpool) seismogram at this time.

NATIONAL INSTITUTE OF OCEANOGRAPHY

Director: Dr. G. E. R. Deacon, C.B.E., F.R.S.

Members of the Institute appear to have been successful in making a seismograph particularly suited for measuring 3–10 sec. microseisms and insensitive to long-period tilt. A systematic analysis of the results so far obtained has not yet been made.

INTERNATIONAL CO-OPERATION

Meetings of the European Seismological Commission in Vienna, April 4–7, 1956

By Ernest Tillotson

The European Seismological Commission, a commission set up by the section for Seismology and the Physics of the Interior of the Earth of the International Union of Geodesy and Geophysics, met in the Institute of Physics of the University of Vienna during April 4–7, under the presidency of Prof. W. Hiller of Stuttgart. The Commission had the support of Unesco, and nineteen countries were represented. The secretary of the B.A. Seismological Committee attended as British representative with the support of the Royal Society.

An account of the meetings was published in *Nature* of June 2, 1956. Four topics were discussed: the organisation and preparation for carrying out large explosions, particularly in Alpine regions, for seismic purposes; the progress achieved in the preparation of a European Earthquake Catalogue and a seismo-tectonic map of Europe; the progress made in the design and construction of seismographs, particularly those to be used to record near earthquakes, and the testing of such instruments; and microseisms. The first experiments in western Europe will be carried out by the French during the second half of August 1956 at Briançon. Such experiments have already been made by the Russians and were described by Prof.

E. F. Savarensky. Mr. E. Tillotson described British work done with smaller quantities of explosives, and considerable interest was shown in the work of Dr. M. N. Hill and his colleagues at sea.

The work of the British Association Seismological Committee in keeping records of British Earthquakes and tremors was also mentioned, as was the work of British seismologists, including Dr. G. E. R. Deacon and his colleagues, and Dr. A. E. M. Geddes on microseisms.

Resolutions were passed and arrangements were made for the continued co-operation in all these matters. The next meeting of the Commission will be held in Utrecht during Whitsuntide, 1958.

By invitation of Prof. W. Hiller, Mr. Tillotson called at Stuttgart on the return journey to see the progress which Prof. Hiller and his colleagues have made with the new short-period seismographs with magnetic amplification for recording on smoked paper. Prototypes of these are now set up in the seismological observatory at Stuttgart.

EDINBURGH SEISMOGRAMS

The secretary has now read the Edinburgh seismograms to the end of 1953.

RESEARCH COMMITTEES, 1956–57

Grants of money, if any, from the Association for expenses connected with researches are indicated in heavy type.

SECTION A.—MATHEMATICS AND PHYSICS

Seismological investigations.—Dr. R. Stoneley, F.R.S. (*Chairman*), Mr. E. Tillotson (*Secretary*), Mr. E. F. Baxter, Miss E. F. Bellamy, Prof. P. G. H. Boswell, O.B.E., F.R.S., Mr. B. C. Browne, Sir Edward Bullard, F.R.S., Dr. K. F. Chackett, Dr. G. E. R. Deacon, F.R.S., Dr. A. T. J. Dollar, Dr. A. E. M. Geddes, O.B.E., Prof. G. R. Goldsbrough, C.B.E., F.R.S., Dr. M. N. Hill, Mr. J. S. Hughes, Sir Harold Jeffreys, F.R.S., Dr. E. R. Lapwood, Rev. C. Rey, S.J., Dr. G. D. Robinson, Mr. H. V. Shaw, Sir Frank Smith, G.C.B., G.B.E., F.R.S.

SECTION C.—GEOLOGY

To excavate critical geological sections in Great Britain.—Mr. W. H. Wilcockson (*Chairman*), Mr. J. M. Edmonds (*Secretary*), Sir Edward Bailey, M.C., F.R.S., Mr. J. L. Begg, Mr. W. S. Bisat, F.R.S., Prof. P. G. H. Boswell, O.B.E., F.R.S., Prof. A. H. Cox, Dr. E. E. L. Dixon, Prof. W. G. Fearnsides, F.R.S., Prof. T. N. George, Prof. H. L. Hawkins, F.R.S., Dr. R. G. S. Hudson, Prof. V. C. Illing, F.R.S., Prof. O . T. Jones, F.R.S., Dr. Murray Macgregor, Mr. T. G. Miller, Prof. L. R. Moore, Dr. F. J. North, O.B.E., Prof. F. W. Shotton, M.B.E., F.R.S., Dr. W. E. Swinton, Dr. F. S. Wallis, Prof. D. M. S. Watson, F.R.S., Prof. T. S. Westoll, Prof. W. F. Whittard, Prof. S. W. Wooldridge, C.B.E. **£30.**

To consider and report on questions affecting the teaching of geology in schools.—Prof. T. N. George (*Chairman*), Dr. Mabel E. Tomlinson (*Secretary*), Prof. J. G. C. Anderson, Miss M. A. Arber, Mr. A. Bray, Prof. W. G. Fearnsides, F.R.S., Dr. J. F. Kirkaldy, Prof. L. R. Moore, Mr. J. Myers, Prof. Sir William Pugh, O.B.E., F.R.S., Dr. K. S. Sandford, Dr. S. H. Straw, Dr. Dighton Thomas, Dr. A. K. Wells, Prof. A. Wood.

SECTIONS C, K.—GEOLOGY, BOTANY

The investigation of Coal Ball Flora, by Dr. H. S. Holden.—Dr. G. Taylor (*Chairman*), Prof. T. M. Harris, F.R.S. (*Secretary*), Mr. W. N. Edwards. **£60.**

SECTIONS D, K.—ZOOLOGY, BOTANY

Co-ordinating committee for Cytology and Genetics.—Prof. K. Mather, F.R.S. (*Chairman*), Mr. Watkin Williams (*Secretary*), Prof. D. G. Catcheside, F.R.S., Dr. J. L. Crosby, Prof. Sir Ronald Fisher, F.R.S., Dr. P. M. Sheppard, Dr. J. M. Thoday.

SECTION E.—GEOGRAPHY

To prepare a glossary of geographical terms with agreed definitions in English, including reference to origin and to current use and misuse. —Prof. L. Dudley Stamp, C.B.E. (*Chairman*), Mr. G. R. Crone (*Secretary*), Prof. H. C. Darby, Prof. W. G. East, Mr. E. O. Giffard, M.B.E., Mr. A. F. Martin, Prof. A. A. Miller, Dr. C. J. Robertson, Mr. C. T. Smith, Dr. G. T. Warwick, M.B.E., Prof. S. W. Wooldridge, C.B.E., Mr. R. A. Skelton.

SECTION H.—ANTHROPOLOGY

To co-operate with a committee of the Royal Anthropological Institute—in the exploration of caves in the Derbyshire district.—Mr. M. C. Burkitt (*Chairman*), Mr. A. Leslie Armstrong, M.C. (*Secretary*), Mr. J. Bartlett, Dr. Arthur Court, Prof. H. J. Fleure, F.R.S., Dr. J. Wilfrid Jackson, Mr. R. U. Sayce. **£10.**

To assist in the work of compiling an *Inventaria Archaeologia* as part of an international enterprise sponsored by the International Congress of Prehistoric Sciences.—Prof. E. O. James (*Chairman*), Dr. D. B. Harden, O.B.E. (*Secretary*), Prof. C. F. C. Hawkes. **£10.**

To carry out research among the Ainu of Japan—Mrs. Brenda Seligman (*Chairman and Secretary*), Prof. Daryll Forde, Lord Raglan, Mr. Arthur Waley, C.B.E. **£10.**

REPORT OF COUNCIL TO THE GENERAL COMMITTEE, 1955–56

(Received and adopted by the General Committee on August 29, 1956)

Obituary

1. Since the Council's last report the Association has mourned the passing of Sir Arthur Trueman, K.B.E., F.R.S. (Past General Secretary, 1951), and has suffered further loss by the death of the following office-bearers and supporters:

Sir Richard W. Allen, C.B.E.
Prof. H. F. Baker, F.R.S.
E. W. Bliss
W. W. Cairns
Sir Robert Waley Cohen, K.B.E.
W. Cullimore
Dr. W. L. H. Duckworth
Sir Lewis Leigh Fermor, O.B.E., F.R.S.
Dr. J. C. Flugel
W. Garven
A. Gow
Prof. W. M. H. Greaves, F.R.S.
Prof. H. R. Hassé
Dr. J. Hettinger
Prof. H. S. Jevons
Dr. T. Johnson
The Hon. Mr. Justice Kimball
Prof. D. Leitch
O. W. F. Lodge
Sir Francis K. McClean
Dr. C. S. Orwin
Sir Richard Paget
Dr. S. G. P. Plant
Prof. R. H. A. Plimmer
Prof. A. R. Radcliffe-Brown
Prof. A. O. Rankine, O.B.E., F.R.S.
Prof. H. R. Robinson, F.R.S.
Dr. R. N. Salaman, F.R.S.
Prof. Wilfred Smith
Dr. W. K. Spencer, F.R.S.
Sir Arthur G. Tansley, F.R.S.
Dr. F. Sherwood Taylor
Sir Harold Tempany, C.M.G., C.B.E.
Dr. S. Whitehead
J. S. Wilson

Relations with other Institutions

2. Representatives of the Association were appointed by the Council as follows:

Indian Science Congress Association, Annual Meeting at Agra, and Pakistan Association for the Advancement of Science, Dacca, January 1956. Prof. G. R. Clemo, Sir George V. Allen.

General Assembly, Society for the Protection of Nature Reserves, Edinburgh, June 1956. Dr. E. Hindle, Dr. C. F. A. Pantin, Dr. J. Ramsbottom, Dr. W. E. Swinton, Dr. G. Taylor.

South African Association for the Advancement of Science, Nelspruit, E. Transvaal, July 1956. Dr. E. A. G. L. Schelpe.

French Association for the Advancement of Science, Dijon, July 1956. Mr. M. G. Bennett.

Twentieth International Geological Congress, Mexico, September 1956. Prof. W. J. Pugh, Dr. W. E. Swinton.

Fifth International Congress of Anthropological and Ethnological Sciences, Philadelphia, September 1956. Prof. M. Fortes.

Pan-African Ornithological Congress, Livingstone, N. Rhodesia, 1957. Dr. E. Hindle, F.R.S.

Advisory Committee of the XVth International Congress of Zoology, London, July 1958. Prof. A. C. Hardy.

3. The Council, through its Officers and Members, have maintained their contacts with scientific and cultural institutions at home and abroad. Dr. George Taylor has been appointed to serve on the Council of the British Institute for

Recorded Sound. Mr. M. G. Bennett has continued to represent the Association on the Parliamentary and Scientific Committee. The Council have acceded to a request from the Director of the Science Museum that the British Association Units of Resistance (Electrical Standards) should be transferred from the National Physical Laboratory to the Science Museum, for permanent custody. The Council have also maintained their annual subscription to the Society for the International Union for the Protection of Nature. Prof. G. R. Clemo and Sir George V. Allen conveyed, on behalf of the Council, the greetings of the British Association to the Meetings of Associations in India and Pakistan. Sir George Allen took part in the ceremony of laying the foundation stone of Pakistan's 'Science House' at Lahore on January 27, 1956. Representatives of sister Associations together with a number of other distinguished overseas guests, including representatives of the organising committees of the International Geophysical Year, will be entertained at Sheffield.

The Council report also that they have offered twenty complimentary memberships to the Overseas Science Students' Association.

Having no meeting-rooms of its own, the Association is indebted to the Royal Society, the Geological Society and the Linnean Society for providing accommodation for Council and Committee meetings held during the year.

UNESCO

4. The Council appointed Sir Ben Lockspeiser to represent the Association at the Unesco Conference on the Dissemination of Science (Madrid, October, 1955). The following resolution was proposed by Sir Ben Lockspeiser, and was adopted unanimously by the Conference:

'1. The conference believes that associations which include in their functions the dissemination of science fulfil a necessary and important need and recommend that practical steps be taken to set up such associations where they do not already exist.

2. The encouragement of the formation of such associations falls within the scope and responsibility of Unesco.

3. The Conference does not consider it necessary or desirable, at present, to set up an international federation or organisation of these associations.

4. The Conference recommends the continuation and strenthening of the existing relations between such associations directly, or through Unesco, when necessary.'

A proposal to set up a standing consultative committee to advise the Director General of Unesco on matters concerned with the dissemination of science was also supported by the Council's representative.

The Council considered an invitation from Unesco to nominate a candidate for the award of the Kalinga Prize for 1956, and decided to do so.

At the request of the Natural Sciences Division of Unesco a revised version of the report on Science Clubs for Young People in Britain, originally prepared in 1949, was sent to Unesco as a further contribution to the study of this method of encouraging interest in science.

FINANCE

5. The General Treasurer's Statement and Account for the financial year ending on March 31, 1956, will be submitted to the General Committee. He has informed Council that the income of the Association from subscriptions, sales of publications, advertising and interest on investments, is insufficient to meet annually recurring expenditure. Although the gap between income and expenditure

had narrowed in recent years, he estimated that the gap would widen to an alarming extent during the next few years. The Council agreed to appoint a Committee to consider the present expenditure and to submit proposals for increasing the annual income of the Association. It was also agreed that this Committee should, in due course, take into account any recommendations made by a Committee of the Division appointed to consider the functions of the Association (*See* paragraph 17 below). The Council will make a special report on Finance and Functions to the General Committee at an early date. (*See p.* 205)

The Council have also to report that J. M. P. Publishing Services have been appointed to succeed Mr. E. H. Harper of Russell & Co. (Southern Counties) Ltd. as Advertisement Contractor to the Association as from January 1, 1956.

The Association was represented on a deputation organised by the National Book League which met the Postmaster General to represent to him the detrimental effect of increased postal rates on Scientific Societies and Associations. The Postmaster General replied as follows:

> 'The Postmaster General has given special consideration to representations which have been made on behalf of societies like yours; but in view of the fact that, even with the new rates, the printed paper post will still be running at a fairly heavy loss, and against a background of rising costs, he is sorry that he has not been able to see his way to making a concession'.

Bristol Meeting

6. The attendance at the Bristol Meeting was 2,987 members, a figure which included 892 student members. The Council are informed that the Local Executive Committee in Bristol, in considering the disposal of the unspent balance of the Local Fund, have decided that after payment to Bristol University of a sum of money for the creation of an open scholarship in science ('The British Association Scholarship') the balance of the fund (approximately £400) should be paid to the General Funds of the Association. The Council wish to record their very deep appreciation for this generous gift. The Council are further indebted to the Local Committee in Bristol for the gift of 350 copies of the scientific survey 'Bristol and its adjoining Counties' for distribution to members who were unable to be present at the Meeting.

Sheffield Meeting

7. The Council wish to record their appreciation of the enthusiasm and efficiency which has distinguished the efforts of their local colleagues in their planning of the Meeting. Sheffield is first and foremost an industrial city, and for this reason the scientific programme will have an industrial slant. The extreme generosity of the Local Committee in Sheffield, in addition to making possible, as last year, the holding of a 'Science in Schools' Exhibition' and the organisation of daily screenings of scientific films—is responsible for a number of additional and greatly welcome attractions which will include an Orchestral and Choral Concert given by the Hallé Orchestra, on Sunday, September 2, and the presentation to each member of a specially designed 'Member's Diary'.

Future Meetings

8. *Dublin*, 1957.—An invitation to meet in Dublin has already been accepted. The Council have received from the Local Executive Committee and recommend for acceptance a proposal that the meeting be held during the period September 4 to 11, 1957. The following Local Honorary Officers have been appointed:

Treasurer: Mr. C. K. Mill; Joint Secretaries: Professor W. Cocker, Professor T. E. Nevin.

The Local Executive Committee have appointed Prof. T. S. Wheeler as Chairman and Mr. G. F. Mitchell as Vice-Chairman of the Organising Committee.

The following have accepted the Council's invitation to serve as Sectional Presidents:

Section		Section	
A	Prof. T. G. Cowling, F.R.S.	H	Prof. C. F. C. Hawkes
B	Dr. J. W. Cook F.R.S.	I	Prof. G. L. Brown, C.B.E., F.R.S.
C	Dr. G. H. Mitchell, F.R.S.	J	Dr. H. G. Maule
D	Prof. J. Z. Young, F.R.S.	K	Prof. J. Doyle
E	Prof. D. L. Linton	L	L. R. Missen C.M.G.
F	Prof. J. E. Meade	M	Sir James Turner
G	Dr. D. S. Anderson		

Assembly of Corresponding Societies: Prof. D. A. Webb.

9. The Council have received invitations from the following cities: York in 1959 and Cardiff in 1960. These invitations have been cordially received by the Council and are submitted to the General Committee for approval.

Officers and Council

10. *President*, 1957.—The Council will make a recommendation to the General Committee.

11. *General Officers*, 1956–57.—The Council nominate for reappointment as General Officers for the year 1956–57:

General Treasurer: Mr. M. G. Bennett.
General Secretaries: Dr. George Taylor and Prof. W. Wardlaw, C.B.E.

12. *Other Members of Council*, 1956–57.—Members retiring under Statute III, 3, are: M. C. Burkitt, Dr. D. B. Harden, Sir Harold Spencer Jones, Dr. J. Ramsbottom, and Dr. N. C. Wright. Under the powers given to them by statute the Council nominate for appointment: Prof. E. O. James, Dr. K. P. Oakley and Dr. H. G. Sanders, leaving two vacancies in the ordinary membership to be filled by the General Committee without nomination by the Council.

The following is the full list of nominations recommended for approval by the General Committee:

J. N. L. Baker
R. J. Bartlett
Prof. L. F. Bates, F.R.S.
Prof. W. Burns
P. Ritchie Calder, C.B.E.
Prof. G. R. Clemo, F.R.S.
Sir Ronald Gould
A. C. Hartley, C.B.E.
Prof. H. R. Hewer
Prof. L. Hunter
Prof. K. S. Isles
Dr. Willis Jackson, F.R.S.
Prof. E. O. James
Prof. H. D. Kay, C.B.E., F.R.S.
Sir Ben Lockspeiser, K.C.B., F.R.S.
Dame Kathleen Lonsdale, D.B.E., F.R.S.
Prof. A. D. Macdonald
James Macdonald, C.B.E.
J. Wickham Murray, O.B.E.
Dr. C. F. A. Pantin, F.R.S.
Dr. K. P. Oakley
Sir William Pugh, O.B.E., F.R.S.
Dr. H. G. Sanders
Dr. W. E. Swinton
Prof. P. E. Vernon
W. H. Wilcockson
Dr. T. Wilson
Prof. S. W. Wooldridge, C.B.E.

The General Committee approved the above nominations and appointed Dr. R. W. Powell and Dr. W. B. Turrill, O.B.E., to fill the remaining vacancies.

13. *Honorary Auditors*, 1956–57: The Council recommend the re-appointment of Sir John Simonsen, F.R.S., and Dr. H. J. T. Ellingham.

Professional Auditors, 1956–57: The Council recommend the re-appointment of W. B. Keen and Co.

General Committee

14. The following have been admitted to membership of the General Committee on the recommendation of Section Committees:

Prof. D. N. de G. Allen
Prof. G. Barnard
Dr. Anna Bidder
D. J. Crowther
A. E. Currall
Miss M. A. Davidson
Wilfred Edwards
Prof. F. C. Frank, F.R.S.
Dr. F. H. Pollard
Prof. C. F. Powell, F.R.S.
Prof. A. G. Quarrell
Prof. W. Sucksmith
Dr. N. A. B. Wilson

Division for the Social and International Relations of Science

15. The Council received and adopted the following resolution which had been passed unanimously by the Conference held to discuss 'Land Use' at Exeter in July, 1955:

> 'That the British Association for the Advancement of Science represent to Her Majesty's Government the importance of arranging for the collection and publication of comprehensive statistics of the present use of all land in this country and to prepare an analysis on a national basis of the development plans now being submitted for approval in such a way that a balance sheet of land use may be drawn up. The Association submits that the collection of this factual information is a vital need in the present stage which town and country planning has reached in this country and in the formulation of national policies of land use.'

This resolution was forwarded by the President of the Association to the Prime Minister, by whom it was acknowledged. The Council later received a considered reply from the Ministry of Housing and Local Government and agreed that no further action was called for at the moment.

16. The Council have approved the appointment of Sir Ben Lockspeiser as Chairman of the Committee of the Division. The following, together with the President and General Officers, have accepted invitations to serve on the Committee:

Prof. P. M. S. Blackett
Mr. P. Ritchie Calder
Mr. E. Blair-Cunynghame
Sir Harold Spencer Jones
Prof. H. D. Kay
Sir Hugh Linstead
Mr. J. L. Longland
Dame Kathleen Lonsdale
Dr. D. C. Martin
Lord Nathan
Prof. L. Dudley Stamp

17. The Council agreed that the Committee of the Division should be asked to consider the functions of the British Association in relation to the present day and to report to the Council.

Research

18. Following the Bristol Meeting the Council appointed ten Research Committees on the recommendation of Sections and made grants to five of them. Details

of the Committees, with their terms of reference, were published in the *Advancement of Science*, Vol. XII, No. 47, page 327.

Biological Stations

19. The Council have agreed that the annual grants of £50 for the rent of tables at Plymouth, Windermere and Naples should be renewed for 1956. In order that fuller use might be made of these tables the Council recommended that the facilities available should be publicised. Applications for the Tables have been invited by a notice in *Nature* and in a letter circulated to the appropriate University Departments.

Memorial Lectures

20. Appointment of the Alexander Pedler and the Norman Lockyer Lecturers for 1956-1957 is under consideration.

Publications

21. *The Advancement of Science* has been published regularly and has maintained a quarterly circulation of some 3,000 copies.

The Council are pleased to report that the generosity of the Local Executive Committee in Sheffield has made it possible to add another volume to the post-war series of Scientific Surveys.

22. The Council reported last year the appointment of an advisory Editorial Committee. The Council have approved the following recommendations from the Committee:

(a) that, beginning with the September 1956 issue, future volumes of *The Advancement of Science* should begin with the September number instead of the June number as at present.

(b) that with effect from September 1956 issue, *The Advancement of Science* should be published in a new format with a redesigned cover and a smoother text-paper capable of taking illustrations and advertisements.

Science and Industry Committee

23. The Council are informed that the final report of the Committee is nearing completion and that it is expected to be printed and published early in 1957.

Scientific Films

24. The Scientific films Committee of the Association, being of the opinion that the film is an important and significant instrument for the dissemination of science to the public, has arranged a major programme of films for daily showing at the Sheffield Meeting. The Council are grateful for the support given to them in this work by the British Universities Films Council and the Scientific Film Association and especially for their agreeing to appoint representatives in alternate years to the Secretaryship of the Committee. The Council wish to thank Mr. A. M. Hughes, Secretary of the Scientific Films Association for making the arrangements for the Sheffield Meeting.

Resolutions

25. Following discussions at the Bristol Meeting the Council received and considered a number of resolutions and recommendations with the following results:

Biological Stations (Sections D, K) The Council agreed that a list should be submitted at the annual meeting to the Committees of Sections D and K showing the names of those whose applications for the use of Tables at Plymouth, Windermere and Naples, during the year, had been approved.

The Geographical Glossary Committee (Section E) The Council approved the recommendation of the Committee of Section E that the Glossary should be published under the auspices of the Association, in co-operation with a commercial publisher, providing that there was no financial obligation incurred.

Shortage of Science Teachers. The following resolution was approved:

'The Council of the British Association being aware of the many representations which have been submitted to Her Majesty's Government concerning the shortage of science teachers, and believing that it is imperative that the position should be improved with the least possible delay,

RESOLVES that a deputation should seek an interview with the Minister of Education to stress to him the serious view taken by leading scientists of the present position, and the importance and urgency of taking all possible action.

It is suggested that the following should be invited to be members of the deputation:

The President (Sir Robert Robinson)
The Lord Adrian
Sir Raymond Priestley
Professor W. Wardlaw
Mr. J. F. Wolfenden'

The appointed deputation met the Minister of Education during October 1955, and were cordially received. Many points mainly concerned with the difficulties involved in finding a solution to the shortage of science teachers were discussed. The Minister expressed a desire to consult representatives of the Association from time to time, to obtain the point of view of scientists in this matter. The Council appointed Sir Raymond Priestley and Professor Wardlaw as its representatives and they had a further meeting with the Minister on May 16.

Biochemical Society. The Council received a resolution from the Committee of the Biochemical Society asking that the institution of a Section of Biochemistry within the Association be considered. The General Officers were deputed by the Council to meet representatives of the Society. At that meeting it was explained that the President and Officers were, at the moment, reviewing the ways in which the Association was carrying out its functions and were considering new forms of organisation which would strengthen its declared aims. The view was put that the Council would be sympathetic to the proposal, and that when plans for re-organisation mature, some way would be found to give due recognition to the claims of Biochemistry.

PRIZES

26. *South Africa Medal*.—The Council is pleased to report that the S. Africa Medal (1905) has been awarded to Dr. Botha de Meillon of the S. African Institute for Medical Research, Johannesburg.

Exhibitioners' Essay.—In view of the slight response to the Council's invitation to Exhibitioners to compete for a prize of £10 for an essay on the Bristol Meeting, it was decided not to make an award for 1955.

Endeavour Essay Prizes, 1956.—The Council gratefully report their acceptance of the offer by the publishers of Endeavour of prizes for scientific essays. In this,

the seventh of the Endeavour Essay Competitions, the subjects set were: research in polar regions, scientific aids to archaeology, the story of steel-making, the chemistry of big molecules, new elementary particles and the control of plant diseases. The successful competitors were: Mr. J. M. Vail (first), Mr. J. W. G. Wignall (second) and Mr. W. Kemp (third). Special prizes for competitors under eighteen years of age were awarded to Mr. D. W. Stebbings and Miss Jennifer Weller.

GENERAL TREASURER'S STATEMENT AND ACCOUNT, 1955–56

THE result of the year's working has turned out much better than was at one time expected. Expenditure has risen by only £104 while Income has remained stationary; and the resultant deficit of £447 has been almost wiped out by the generous gift of the surplus of the Bristol Local Fund amounting to £399. The Association is most grateful to its Bristol hosts, also, for the institution of a B.A. Scholarship at the University. There are no very remarkable changes in individual items in the Accounts, except perhaps the reduction of over £100 in printing costs.

That an undertaking of the size of the Association can be run on such a small turnover, is, of course, due to the great generosity of our hosts in money and man-power and to the efficiency and enthusiasm of the surprisingly small permanent staff at Headquarters.

The financial position of the Association is again much as it was for very many years before the War, when there were varying deficits of a few hundred pounds, masked by non-recurring donations and subsidies. While there is some satisfaction in having reduced the large deficit of the 1950's to these proportions, the matter cannot be allowed to rest there. It is to be hoped that means will be found, not merely to eradicate the deficit, but to provide a substantial balance in hand with which to finance wider activities of the Association in the service of Science.

M. G. BENNETT,
General Treasurer.

Balance Sheet, 31st March, 1956

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

LIABILITIES

		£ s. d.	£ s. d.
GENERAL PURPOSES :—			
Sundry Creditors		1,077 11 4	
Amounts received in advance for publications		221 9 3	
Membership and Associateship subscriptions in advance		167 6 0	
Amount temporarily held on behalf of Seismological Investigations Committee (Dr. J.E. Crombie's bequest) as per last Account	1,000 0 0		
Less amount repaid	500 0 0		
		500 0 0	
Cash overdrawn at bank		893 7 9	
			2,859 14 4
Accumulated Fund			
As per last Account	40,966 12 4		
Less loss on conversion of 3% Defence Bonds	1 0 3		
	40,965 12 1		
Less Excess of Expenditure over Income for the year on General Account	47 15 11		
		40,917 16 2	
Add further amount received under will of Mrs. Winifred Phillips		50 0 0	
			40,967 16 2
Life Membership Fund			
As per last Account		8,441 15 4	
Add Subscriptions received during year		220 10 0	
			8,662 5 4
[51,905 16 2]			52,489 15 10
Development Fund			
As per last Account		6,437 13 0	
Add Excess of Income over Expenditure for the year		166 0 3	
[6,437 13 0]			6,603 13 3
[58,343 9 2]			£59,093 9 1
SPECIAL PURPOSES :—			
Caird Fund			
Capital		9,511 9 11	
Income and Expenditure Account balance as per last Account	740 4 5		
Add Excess of Income over Expenditure for the year	135 13 11		
		875 18 4	
[10,251 14 4]			10,387 8 3
Toronto University Presentation Fund			
Capital		178 11 4	
Income and Expenditure Account balance as per last Account	4 16 6		
Add Excess of Income over Expenditure for the year	5 10 3		
		10 6 9	
[183 7 10]			188 18 1
Bernard Hobson Fund (1933)			
Capital		1,093 2 6	
Income and Expenditure Account balance as per last Account	348 0 10		
Add Excess of Income over Expenditure for the year	12 9 1		
		360 9 11	
[1,441 3 4]			1,453 12 5
Leicester and Leicestershire Fund (1933)			
Capital		1,000 0 0	
Income and Expenditure Account balance as per last Account	185 15 2		
Add Excess of Income over Expenditure for the year	30 15 9		
		216 10 11	
[1,185 15 2]			1,216 10 11
13,062 0 8]	Carried forward		13,246 9 8

ASSETS

	£ s. d.	£ s. d.
GENERAL PURPOSES :—		
Investments as scheduled with Income and Expenditure Account, No. 1	51,372 13 9	
Sundry debtors	953 18 2	
Stock of Badges	156 19 6	
Cash in hand	6 4 5	
[51,905 16 2]		52,489 15 10
Development Fund		
Investments (see Income and Expenditure Account, No. 2)	5,978 7 0	
Cash at bank	625 6 3	
[6,437 13 0]		6,603 13 3
[58,343 9 2]		£59,093 9 1
SPECIAL PURPOSES :—		
Caird Fund		
Investments (see Income and Expenditure Account, No. 3)	9,911 9 11	
Cash at bank	475 18 4	
[10,251 14 4]		10,387 8 3
Toronto University Presentation Fund		
Investment (see Income and Expenditure Account, No. 4)	178 11 4	
Cash at bank	10 6 9	
183 7 10]		188 18 1
Bernard Hobson Fund (1933)		
Investments (see Income and Expenditure Account, No. 5)	1,243 2 6	
Cash at bank	210 9 11	
[1,441 3 4]		1,453 12 5
Leicester and Leicestershire Fund (1933)		
Investments (see Income and Expenditure Account, No. 6)	1,000 0 0	
Cash at bank	216 10 11	
[1,185 15 2]		1,216 10 11
[13,062 0 8]	Carried forward	13,246 9 8

Balance Sheet, 31st March, 1956 (*continued*)

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

LIABILITIES (*continued*)	£ s. d.	£ s. d.
[13,062 0 8] Brought forward		13,246 9 8
Radford Mather Lecture Fund (1936)		
Capital	242 18 0	
Income and Expenditure Account balance as per last Account . 38 6 4		
Add Excess of Income over Expenditure for the year . . . 7 6 8		
	45 13 0	
[281 4 4]		288 11 0
Arthur Haydock Bequest (1945)		
Capital	2,215 12 0	
Income and Expenditure Account balance as per last Account . 636 6 3		
Add Excess of Income over Expenditure for the year . . . 73 19 11		
	710 6 2	
[2,851 18 3]		2,925 18 2
Corcoran Gift (1946)		
Capital	100 0 0	
Income and Expenditure Account balance as per last Account . 16 5 5		
Add Excess of Income over Expenditure for the year . . . 3 5 1		
	19 10 6	
[116 5 5]		119 10 6
Science and Industry Committee		
Board of Trade grants . .	6,100 19 1	
Department of Scientific and Industrial Research grants . . .	1,492 7 5	
	7,593 6 6	
Less Amounts transferred to the Committee	7,593 6 6	
[– – –]		– – –
[16,311 8 8]		£16,580 9 4

ASSETS (*continued*)	£ s. d.	£ s. d.
[13,062 0 8] Brought forward		13,246 9 8
Radford Mather Lecture Fund (1936)		
Investment (see Income and Expenditure Account, No. 7) .	242 18 0	
Cash at bank	45 13 0	
[281 4 4]		288 11 0
Arthur Haydock Bequest (1945)		
Investments (see Income and Expenditure Account, No. 8) .	2,465 12 0	
Cash at bank	460 6 2	
[2,851 18 3]		2,925 18 2
Corcoran Gift (1946)		
Investment (see Income and Expenditure Account, No. 9) . .	100 0 0	
Cash at bank	19 10 6	
[116 5 5]		119 10 6
Science and Industry Committee		
Cash at bank	– – –	
[– – –]		– – –
[16,311 8 8]		£16,580 9 4

We have examined the foregoing Account with the Books and Vouchers and certify the same to be correct. We have also verified the Balance at the Bankers and the Investments.

Approved:
J. L. SIMONSEN
H. J. T. ELLINGHAM } *Auditors.*

W. B. KEEN & CO., *Chartered Accountants*,
Finsbury Circus House, Blomfield St., E.C. 2.

INCOME AND EXPENDITURE ACCOUNTS FOR THE YEAR ENDED 31st MARCH, 1956

No. 1. General Income and Expenditure

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

		£ s. d.
	Investments at cost :	
	£8,264 4s. 4d. Consolidated 2½ per cent. Stock	6,401 3 0
	£1,999 0s. 4d. British Gas 3 per cent. Stock, 1990/95	1,520 14 10
	£18,400 0s. 0d. 3 per cent. Savings Bonds, 1965/75	19,098 11 9
	£52 12s. 7d. 3½ per cent. War Stock (Post Office issue)	54 5 2
	£7,704 6s. 2d. 3½ per cent. War Stock	7,840 0 9
	£6,768 15s. 7d. 3½ per cent. Conversion Stock, 1961 or after	5,726 8 11
	£4,184 18s. 2d. 2½ per cent. Treasury Stock, 1975 or after	4,184 18 2
	£1,400 0s. 0d. 4 per cent. Funding Loan Stock, 1960/90	1,622 0 0
	£981 10s. 0d. 4 per cent. Commonwealth of Australia Stock 1955/70	1,000 0 0
	£4,897 18s. 11d. 3 per cent. British Transport Stock, 1978/88	3,824 11 2
	£100 0s. 0d. 3½ per cent. Defence Bonds	100 0 0
[51,373 14 0]	*[Value of stocks at 31/3/55, £44,727 18s. 3d.]* (Value at 31/3/56, £38,040 14s. 1d.)	£51,372 13 9

EXPENDITURE

	£ s. d.	£ s. d.
Heat, Lighting and Power	106 11 11	
Rewiring for electric lighting	12 18 0	
		119 9 11
Stationery		371 18 4
New Typewriter		59 10 0
Rent		1 0 0
Postages		420 6 3
Telephone		57 1 5
Insurances		11 19 8
Travelling expenses		519 2 8
Audit for 1954–55		115 10 0
Exhibitioners :	184 10 4	
Less Contribution by Liverpool University	60 0 0	
		124 10 4
Subscription to Parliamentary and Scientific Committee		15 15 0
Subscription to International Union for the Protection of Nature (2 years)		10 0 0
Hire of meeting rooms, equipment, etc.		30 2 2
Norman Lockyer Lecture fee		10 10 0
Alexander Pedler Lecture fee		10 10 0
Lift Inspection and Repairs		17 6 6
Carriage of goods		35 6 6
Reference books, press cuttings, etc.		26 15 3
General expenses		76 12 2
Panels of armorial bearings		14 9 8
Scientific Films at Annual Meeting		79 7 11
Salaries, wages, pensions and National Insurance		4,599 11 1
Printing, etc.—		
"The Advancement of Science"	2,610 16 7	
Preliminary Programme, 1955	406 9 8	
Programme, 1955	737 11 3	
Miscellaneous	321 5 8	
		4,076 3 2
Hospitality		170 3 3
Membership badges used		111 6 2
Legal advice		35 19 0
Temporary clerical assistance		45 10 0
[11,062 1 3]		£11,165 16 5

INCOME

	£ s. d.	£ s. d.
Membership subscriptions		6,172 12 0
Sale of Publications :		
"The Advancement of Science"	786 4 3	
Other items	81 8 9	
		867 13 0
Advertisements in B.A. publications :		
"The Advancement of Science"	656 17 10	
Preliminary Programme, 1955	228 19 8	
Programme, 1955	454 5 9	
		1,340 3 3
Income Tax recovered to 31st March, 1955 :		
On Interest and Dividends	81 15 8	
„ covenanted subscriptions	536 12 2	
		618 7 10
Interest on Investments		1,606 14 0
Donations received	45 9 6	
Donation by Local Committee for the Bristol Meeting, 1955	398 14 2	
		444 3 8
Charges for administration of Special Funds		68 6 9
[10,717 4 10]		11,118 0 6
Balance, being excess of Expenditure over Income for the year		47 15 11
[344 16 5]		
[11,062 1 3]		£11,165 16 5

No. 2. Development Fund

An Appeal for a Development Fund to be used under the direction of the Council, was made at the Annual Meeting at Dundee in 1947. The fund is still open.

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

		£ s. d.
	Investments at cost :	
	£2,745 19*s.* 0*d.* London County 2½ per cent. Consolidated Stock, 1960/70	2,750 0 0
	£3,387 14*s.* 10*d.* Savings 3 per cent. Stock, 1965/75	3,028 7 0
	£292 15*s.* 3*d.* Consolidated 2½ per cent. Stock	200 0 0
	[*Value of stocks at 31/3/55,* £5,559 5*s.* 11*d.*] (Value at 31/3/56, £4,815 0*s.* 4*d.*)	
[5,978 7 0]		£5,978 7 0
	Cash at bank	£625 6 3

EXPENDITURE

	£ s. d.		£ s. d.
Office alterations, etc. [323 0 2]	– – –	Interest	184 9 2
Administration charge [24 7 0]	18 8 11	Income Tax recovered [243 9 10]	– – –
Balance, being excess of Income over Expenditure for the year [– – –]	166 0 3	Balance, being excess of Expenditure over Income for the year [103 17 4]	– – –
[347 7 2]	£184 9 2	[347 7 2]	£184 9 2

No. 3. Caird Fund

The unconditiona gift of Sir James Caird, in 1912, administered by the Council in accordance with recommendations adopted by the General Committee in 1913.

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

		£ s. d.
	Investments at cost :	
	£2,904 11*s.* 8*d.* British Gas 3 per cent. Stock, 1990/95	2,209 13 0
	£2,716 16*s.* 6*d.* 3½ per cent. War Stock	2,516 15 5
	£4,282 18*s.* 9*d.* 3 per cent. British Transport Stock, 1978/88	4,785 1 6
	£585 10*s.* 6*d.* Consolidated 2½ per cent. Stock	400 0 0
	[*Value of stocks at 31/3/55,* £8,667 4*s.* 6*d.*] (Value at 31/3/56, £7,276 8*s.* 0*d.*)	
[9,911 9 11]		£9,911 9 11
	Cash at bank	£475 18 4

EXPENDITURE

	£ s. d.	£ s. d.
Rent of tables for 1956 at Biological Stations:		
Naples Zoological Station	50 0 0	
Freshwater Biological Association, Windermere	50 0 0	
Marine Biological Association, Plymouth	50 0 0	
		150 0 0
Grant to Research Committee:		
Ainu of Japan		10 0 0
Administration charge		32 17 1
[247 10 8]		192 17 1
Balance, being excess of Income over Expenditure for the year [77 15 10]		135 13 11
[325 6 6]		£328 11 0
Grants authorised, not yet drawn :—		
Glossary of Geographical Terms	5 0 0	
Inventoria Archaeologica	10 0 0	
[10 0 0]	£15 0 0	

INCOME

	£ s. d.
Interest	270 14 8
Income Tax recovered	57 16 4
[325 6 6]	£328 11 0

No. 4. Toronto University Presentation Fund

A fund voluntarily subscribed by members present at the Toronto Meeting in 1924. In June 1954 the Council, with the approval of the University of Toronto, decided to expend the fund on the purchase of a Presidential Badge to be called the Toronto Badge, instead of providing two bronze medals annually together with books for presentation to selected students.

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

		£ s. d.
	Investment at cost :	
	£175 0s. 0d. 3½ per cent. War Stock	178 11 4
[Value of stock at 31/3/55, £149 12s. 6d.]	(Value at 31/3/56, £128 12s. 6d.)	
£178 11s. 4d.]		£178 11 4
	Cash at bank	£10 6 9

EXPENDITURE	£ s. d.		INCOME	£ s. d.
Administration charge *[– 12 3]*	12 3		Interest	6 2 6
Cost of medals *[5 9 0]*	– – –			
Balance, being excess of Income over Expenditure for the year *[– 1 3]*	5 10 3			
[6 2 6]	£6 2 6	*[6 2 6]*		£6 2 6

No. 5. Bernard Hobson Fund

The bequest of Mr. Bernard Hobson, 1933; the income to be applied to the promotion of geological research; administered by the Council.

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

		£ s. d.
	Investments at cost :	
	£50 0s. 0d. 4 per cent. Victory Bonds	55 10 5
	£601 9s. 0d. 2½ per cent. Treasury Stock, 1975 or after	601 9 0
	£416 0s. 11d. 3½ per cent. War Stock	436 3 1
	£178 16s. 4d. Consolidated 2½ per cent. Stock	150 0 0
[Value of stocks at 31/3/55, £889 18s. 1d.]	(Value at 31/3/56, £769 9s. 9d.)	
[1,243 2 6]		£1,243 2 6
	Cash at bank	£210 9 11

EXPENDITURE	£ s. d.		INCOME	£ s. d.
Administration charge *[3 12 1]*	3 12 1		Interest	36 1 2
Grant *[– – –]*	20 0 0			
Balance, being excess of Income over Expenditure for the year *[32 9 1]*	12 9 1			
[36 1 2]	£36 1 2	*[36 1 2]*		£36 1 2
Grant authorised, not yet drawn :— Critical Geological Sections	30 0 0			
[50 0 0]	£30 0 0			

No. 6. Leicester and Leicestershire Fund, 1933

The unexpended balance of the local fund for the Leicester Meeting in 1933, presented to the Association, the interest to be used in assisting by scholarships or otherwise students working for the advancement of science; administered by the Council.

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

		£ s. d.
	Investments at cost :	
	£487 2s. 11d. 3½ per cent. Conversion Stock	500 0 0
	£490 5s. 11d. 3½ per cent. War Stock	500 0 0
[Value of stocks at 31/3/55, £835 14s. 4d.]	(Value at 31/3/56, £708 13s. 8d.)	
[1,000 0 0]		£1,000 0 0
	Cash at bank	£216 10 11

EXPENDITURE	£ s. d.		INCOME	£ s. d.
Grant *[30 0 0]*	– – –		Interest	34 4 2
Administration charge *[3 8 5]*	3 8 5			
Balance, being excess of Income over Expenditure for the year *[– 15 9]*	30 15 9			
[34 4 2]	£34 4 2	*[34 4 2]*		£34 4 2

No. 7. Radford Mather Lecture Fund

A gift of £250 received from Mr. G. Radford Mather in 1936 to establish a Fund, the income therefrom to be devoted to meeting the expense of triennial Lectures on Recent Advances in Science and their relation to the Welfare of the Community.

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

		£ s. d.
	Investment at cost :	
	£271 14s. 6d. Savings 3 per cent. Stock, 1965/75	242 18 0
	[*Value of stock at 31/3/55, £240 9s. 6d.*] (Value at 31/3/56, £205 3s. 0d.)	
[*242 18 0*]		£242 18 0
	Cash at bank	£45 13 0

EXPENDITURE	£ s. d.	INCOME	£ s. d.
Lecture fee and fare [*22 1 10*]	– – –	Interest [*8 3 0*]	8 3 0
Administration charge [*1 0 0*]	16 4	Income Tax recovered [*1 16 8*]	– – –
Balance, being excess of Income over Expenditure for the year [– – –]	7 6 8	Balance, being excess of Expenditure over Income for the year [*13 2 2*]	– – –
[*23 1 10*]	£8 3 0	[*23 1 10*]	£8 3 0

No. 8. Arthur Haydock Bequest

A bequest received in 1945 "for the purpose of original investigation of problems relating to either or both of Geology or Botany as may be determined by the governing body of the British Association."

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

		£ s. d.
	Investments at cost :	
	£2,090 4s. 0d. 3½ per cent. Conversion Stock	2,215 12 0
	£362 6s. 3d. Consolidated 2½ per cent. Stock	250 0 0
	[*Value of stocks at 31/3/55, £2,017 3s. 9d.*] (Value at 31/3/56, £1,688 6s. 7d.)	
[*2,465 12 0*]		£2,465 12 0
	Cash at bank	£460 6 2

EXPENDITURE	£ s. d.	INCOME	£ s. d.
Administration charge [*8 4 5*]	8 4 5	Interest	82 4 4
Balance, being excess of Income over Expenditure for the year [*73 19 11*]	73 19 11		
[*82 4 4*]	£82 4 4	[*82 4 4*]	£82 4 4
Grant authorised, not yet drawn :— Coal Ball Flora	60 0 0		
[– – –]	£60 0 0		

No. 9. Corcoran Gift

A gift of £100 received in 1946 for research in memory of Miss J. R. Corcoran.

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

		£ s. d.
	Investment at cost:	
	£144 18s. 6d. Consolidated 2½ per cent. Stock	100 0 0
	[*Value of stock at 31/3/55, £92 0s. 7d.*] (Value at 31/3/56, £77 10s. 9d.)	
[*100 0 0*]		£100 0 0
	Cash at Bank	£19 10 6

EXPENDITURE	£ s. d.	INCOME	£ s. d.
Administration charge	7 3	Interest	3 12 4
Balance, being excess of Income over Expenditure for the year	3 5 1		
[*3 12 4*]	£3 12 4	[*3 12 4*]	£3 12 4

SHEFFIELD MEETING

SECTIONAL TRANSACTIONS

Any references to publication supplied by authors will be found in the list below. References indicated by 'cf.' are to appropriate works quoted by the authors of papers, not to the papers themselves.

SECTION A

MATHEMATICS AND PHYSICS

August 30

Physics and technology, Presidential Address by Sir George Thomson, F.R.S.

Dr. L. Essen.—*The measurement of the velocity of light.*

August 31

Radio astronomy:

Dr. J. G. Davies.—*Radio observation of meteors.*

Mr. J. R. Shakeshaft.—*Radio stars.*

Cf. 'A survey of radio sources between declinations −38° and +83°, *Mem. R.A.S.* **67,** 106, 1955, by J. R. Shakeshaft, M. Ryle, J. E. Baldwin, B. Elsmore & J. H. Thomson; 'The spatial distribution and the nature of radio sources', M. Ryle & P. A. C. Schener, *Proc. roy. Soc.* A, 230, 448, 1955; cf. also article by M. Ryle in Sept. 1956; issue of *Sci. American.*

Prof. H. S. W. Massey, F.R.S.—*The discovery and significance of the anti-proton.*

September 3

The physical properties of metals:
Nature, **178,** 614–16, (Sept. 22, 1956).

Prof. A. G. Quarrell.—*The physical approach to metallurgy.*

Prof. C. S. Smith.—*The microstructure of metals and alloys.*

'Microstructure' (Campbell Memorial Lecture, 1952), *Trans. Amer. Soc. Metals*, **45,** 533–75 (1953); 'Grain Shapes and Other Metallurgical Applications of Topology', in *Metal Interfaces*, American Society for Metals, Cleveland (1952), pp. 65–113; 'The Structure of Metals as Seen under the Microscope', *Proc. roy. Instn G.B.* (1956).

Dr. N. J. Petch.—*Brittle fracture.*

Mr. L. Rotherham.—*The metallurgy of atomic energy.*

To appear in *J. appl. Phys.*

September 4

Session A

Utilisation of fuels. (Joint Session with Section G (Engineering):

Prof. M. W. Thring.—*Recent developments in the physics of fuel combustion.*

Prof. A. D. Baxter.—*Rocket propellants.*

Mr. W. G. E. Lewis.—*Aerodynamic factors in combustion in gas turbines.*

Miss M. V. Griffith.—*Salvage of waste heat by means of the heat pump.*

Session B

Rock magnetism and polar wandering:
Account to appear in *Nature.*

Prof. P. M. S. Blackett, F.R.S.—*Rock magnetism: the history of the earth's field and the movement of the Poles and the Continents.*

Cf. 'Lectures on Rock Magnetism', Weizmann Science Press of Israel.

Dr. A. E. M. Nairn.—*Polar wandering.*

Cf. 'The relevance of palaeomagnetic studies of Jurassic rocks to Continental drift', *Nature*, **178** (1956).

Dr. J. A. Clegg.—*Rock magnetism.*

September 5

The properties of magnetic materials. (Joint Sessions with Section G (Engineering):

Prof. W. Sucksmith, F.R.S.—*Developments in magnetic materials.*

Dr. E. W. Gorter.—*Ferromagnetic oxides.*

Dr. A. Edwards.—*Industrial permanent magnets.*

SUB-SECTION A *

MATHEMATICS

August 31

Statistical methods in industry:

Prof. G. A. Barnard.—*Economic aspects of statistical procedures.*

Dr. G. E. P. Box.—*Evolutionary operation.*

Dr. G. H. Jowett.—*The effect of non-randomness on tests of significance.*

SECTION B

CHEMISTRY

August 30

Chemistry at high temperatures:

Steelmaking since Bessemer, Presidential Address by Sir Charles Goodeve, O.B.E., F.R.S.

Dr. James Taylor, M.B.E.—*The manufacture of titanium.*

To appear in *Metal Industry.*

Prof. George Porter.—*Very high temperature reactions.*

Chemistry (U.S.A.); account may appear in *Endeavour.*

August 31

Anti-oxidants :
Nature, **178**, 775–7, (Oct. 13, 1956).

Prof. R. D. Haworth, F.R.S. (*Chairman*).

Prof. C. E. H. Bawn, F.R.S.—*Introduction.*

Dr. C. H. Lea.—*Anti-oxidants in the food industry.*
To appear in *Research*; cf. 'Problems arising from the use of chemicals in food-antioxidants', *Chem. and Industry*, 1952, pp. 178–83.

Mr. C. N. Thompson.—*Anti-oxidants in the oil industry.*
Chemical Age, **75** (1939) 441 (Sept. 8, 1956); *Engineering*, **182** (4723) 322 (Sept. 14, 1956); *Nature*, **178**, 775–6 (Oct. 13, 1956); *Chemistry and Industry*, Oct. 13, 1956, p. 1083.

Mr. J. T. Watts.—*Anti-oxidants in the rubber industry.*

September 3

Metals in living systems :
Nature, **178**, 889–91 (Oct. 27, 1956).

Sir Rudolph Peters, F.R.S. (Chairman). *Introduction.*

Prof. A. Neuberger, F.R.S.—*The biogenesis of porphyrins.*
Account to appear in *Nature*. Cf. A. Neuberger, *et al.* (1956), *Biochem. J.* **64**, 80, 90, 137; A. Neuberger (1955), 3rd Int. Cong. Biochemistry, Brusselles. Proceedings; K. D. Gibson, A. Neuberger & J. J. Scott (1955), *Biochem. J.* **61**, 618; A. Neuberger & J. J. Scott (1954), *J. chem. Soc.* p. 1820; A. Neuberger & J. J. Scott (1953), *Nature, Lond.* **172**, 1093.

Dr. C. P. Whittingham.—*Metal catalysts of the green plant.*
To appear in *Nature*.

Dr. D. P. Cuthbertson.—*Actions and applications.*
Account to appear in *New Scientist*; cf. *Adv. of Sci.* **49**, 485 (June, 1956).

September 4

Glass—recent research and development :
Nature, **178**, 831–2 (Oct. 20, 1956).

Prof. R. W. Douglas (*Chairman*).

Prof. W. E. S. Turner, O.B.E., F.R.S.—*Introduction.*

Prof. R. W. Douglas.—*Some aspects of the vitreous state.*

Mr. W. J. R. Merren.—*Special glasses.*

Mr. A. De Dani and Mr. P. E. Jellyman.—*Glass fibre forming.*
To appear in *J. Glass Tech.*

Dr. J. H. Partridge.—*New glasses demanded by the electronics industry.*

SECTION C

GEOLOGY

August 30

Prof. L. R. Moore.—*The geology of the Sheffield district.*

Mr. Wilfrid Edwards.—*The Yorkshire and East Midlands Coalfield.*

Mr. P. L. Collinson and Mr. R. F. Goossens.—*The Yorkshire and East Midlands Coalfield.*

August 31

The Geology of Kilimanjaro :
Nature, **178**, 828–30 (Oct. 20, 1956).

Mr. W. H. Wilcockson.—*Introduction.*

Mr. P. Wilkinson.—*Succession and structure.*

Mr. W. H. Wilcockson.—*Petrology.*

Dr. C. Downie.—*Glacial history.*

Dr. D. W. Humphries.—*Glaciology and vulcanology.*

September 3

The presentation of geological information in maps, Presidential Address by Dr. T. Robertson.

The Derbyshire Limestone problems :

Mr. R. A. Eden.—*Aspects of the stratigraphy of the* Dibunophyllum *zone.*

Prof. F. W. Cope.—*New evidence of the basal Carboniferous sediments in Derbyshire.*

Mr. A. Ludford.—*The Dovedale, Manifold and Weaver Hills region.*

September 4

Antarctic research. (Joint session with Section E (Geography)·
Nature, **178**, 773–5 (Oct. 13, 1956).

Sir Raymond Priestley, M.C. (*Chairman*).

Dr. V. E. Fuchs.—*The Trans-Antarctic Expedition.*

Dr. R. J. Adie.—*Geological research in Graham Land.*

Mr. D. H. Maling.—*Some geographical results of the work of the Falkland Island Dependencies Survey 1944–55.*

Mr. H. H. Lamb.—*Winds and weather in the Antarctic.*

Dr. W. Campbell Smith, C.B.E., M.C.—*Some geological results of the Expeditions to South Victoria Land up to 1914.*
Cf. British Antarctic ('Terra Nova') Expedition, 1910, Natural History Report. Geology. Vol. 1, No. 5, 'The Metamorphic Rocks of South Victoria Land' (with F. Debenham & R. E. Priestley (1921); Vol. 1, No. 6, 'The plutonic and hypabyssal rocks of South Victoria Land' (1924); Vol. 2, No. 1, 'The Volcanic Rocks of the Ross Archipelago' (1955). In preparation: Vol. 2, No. 2, 'The Volcanic Rocks of Cape Adare' (1957).

Micropalaeontology and Carbonaceous rocks :

Prof. L. R. Moore.—*Some microfossils from a Chert in the Scottish Oil Shales.*

Dr. C. Downie.—*Microplankton from the Shineton Shales preserved in organic matter.*

Mr. L. G. Love.—*A new group of micro-organisms from Carbonaceous rocks.*
To be submitted to *Quart. J. geol. Soc.* as 'Micro-organisms and the presence of syngenetic pyrite'.

Dr. T. Barnard.—*Microfossils from the Chalk.*

Dr. J. E. Robinson.—*Some aspects of the micropalaeontology of the Scremerston Coal Group.*

Mr. A. J. Lloyd.—*Arenaceous foraminifera in the Kimcridge Clay.*

September 5

Dr. R. M. C. Eagar.—*Non-marine succession above the Flockton Coals* (modiolaris *Zone*) *of the Yorkshire Coal Measures between Wakefield and Rotherham.*
To be submitted to *Quart. J. geol. Soc.* and *Geol. Mag.*

Mr. R. E. H. Reid.—*On the Hexactinellida of the Chalk Rock.*

Dr. D. L. Dineley and Mr. P. A. Garrett.—*The stratigraphy and structure of the Carboniferous and Permian rocks south of St. Jonsfjorden, Vestspitsbergen.*

Dr. E. L. P. Mercy.—*A new geochemical technique.*

Dr. E. M. Patterson.—*Vent agglomerates in relation to lava stratigraphy.*
To appear in *Proc. R. Irish Acad.*; cf. *Proc. R. Irish Acad.* **57,** B, 79–121.

SECTION D

Zoology

August 30

The implications of the study of animal behaviour, Presidential Address by Dr. W. H. Thorpe, F.R.S.

The contribution of zoological research to theories of animal learning:
Nature, **178,** 612–14 (Sept. 22, 1956).

Dr. Peggy E. Ellis.—*Does imprinting occur in locusts?*

Mr. S. A. Barnett.—*Animal motility and learning.*

Dr. R. A. Hinde.—*The significance of Imprinting.*

Dr. I. M. L. Hunter.—*'Trial and error' versus 'Insight'.*

Dr. A. J. Watson.—*'Stimulus-response' theories of animal learning in the light of work on instinctive behaviour.*

Mr. R. L. Reid.—*A discussion of some of the disadvantages of excessive theorising about behaviour, with suggestions for a less theoretical approach that would reduce controversy.*

Summing-up by Dr. W. H. Thorpe, F.R.S.

August 31

Blood Groups and Anthropology. (See entry under Section H.)

Zoology of the Antarctic:

Sir Raymond Priestley, M.C.—*Introduction.*

Dr. N. A. Mackintosh, C.B.E.—*General survey.*

Dr. R. M. Laws.—*Antarctic seals.*

Mr. B. Stonehouse.—*Birds of Antarctica.*

Dr. G. C. L. Bertram.—*Commercial exploitation of the Antarctic fauna.*

The structure and growth of wool and other animal fibres:
Nature, **178,** 771–3 (Oct. 13, 1956).

Dr. A. B. Wildman.—*Fleece growth.*

Dr. M. L. Ryder.—*The blood supply to the skin and wool follicles of sheep.*
Cf. 'Use of Cyanol in the study of blood vessels in sheep skin', *Nature*, **172,** 125 (1953); 'The demonstration of blood vessels in microscopical preparations', *The Microscope*, **10,** 85–9 (1954); 'Studies on the nutrition of wool follicles in sheep: the anatomy of the general blood supply to the skin', *J. agric. Sci.* **45,** 311–26 (1955); 'The blood supply to the wool follicle', *Proc. 1st. Int. Wool Textile Res. Conference, Australia* (1955). Publication in press.

Dr. L. Auber.—*Comparison of development of fibres and related structures.*

Mr. H. B. Carter.—*The determinants of fleece structure in the Merino and its crosses.*

Dr. F. Happey.—*The fine structure of the protein fibre.*

September 3

Recent studies on British mammals:

Mr. T. J. Pickvance.—*Introduction: the work of the Mammal Society.*

Dr. C. E. Ford, Mr. G. B. Sharman and Mr. J. L. Hamerton.—*Chromosome polymorphism in the Common Shrew.*

Prof. H. R. Hewer.—*Reproduction and ageing in the Grey Seal.*

Mrs. G. Hickling.—*The Grey Seals of the Farne Islands.*
Cf. *Trans. nat. Hist. Soc.*, Vol. X, pp. 165–82, 'The grey seals of the Farne Islands', by I. M. Telfer & G. Watt; Vol. XI, pp. 153–63, 'The grey seals of the Farne Islands', by G. Hickling, A. W. Jones & I. M. Telfer; Vol. XI, pp. 230–44, 'The grey seals of the Farne Islands', by G. Hickling, A. W. Jones & I. M. Telfer.

Mr. M. Blackmore.—*The duration of activity in British bats.*

Mr. F. J. Taylor Page.—*Revival of the study of British deer.*
Cf. *Bull. Mammal Soc.* No. 3 (Feb. 1955).

The Genetics of micro-organisms. (Joint Session with Section K (Botany):

Prof. D. G. Catcheside, F.R.S.—*Introduction.*

Dr. G. H. Beale.—*Genetics of antigens of* Paramecium.

Dr. C. Quadling.—*Bacterial motility and cellular variation.*
(For ref. see entry under Section K).

Mr. S. W. Glover.—*Transduction of biochemical mutants in* Salmonella.

Mr. K. G. McWhirter.—*Genetic latency in inherited viruses and its significance for evolution.*

Eelworms:

Dr. D. W. Fenwick.—*Larval emergence from free eggs of* Heterodera rostochiensis.

Dr. H. R. Wallace.—*The influence of soil structure on the migration of beet eelworm.*

Cf. Wallace, H. R. (1954), 'Hydrostatic pressure deficiency and the emergence of larvae from cysts of the beet eelworm', *Nature, Lond.* **173,** 502; Wallace, H. R. (1955a), 'Factors influencing the emergence of larvae from cysts of the beet eelworm, *Heterodera schachtii* Schmidt', *J. Helminth.* **29,** 3; Wallace, H. R. (1955b), 'The influence of soil moisture on the emergence of larvae from cysts of the beet eelworm *Heterodera schachtii* Schmidt', *Ann. appl. Biol.* **43,** 477; Wallace, H. R. (1956a), 'Migration of nematodes', *Nature, Lond.* **177,** 287; Wallace, H. R. (1956b), 'Soil aeration and the emergence of larvae from cysts of the beet eelworm *Heterodera schachtii* Schmidt', *Ann. appl. Biol.* **44,** 57; Wallace, H. R. (1956c), 'The effect of soil structure on the emergence of larvae from cysts of the beet eelworm', *Nematologica,* **1,** 145; Wallace, H. R. (1956d), 'The seasonal emergence of larvae from cysts of the beet eelworm *Heterodera schachtii* Schmidt', *Nematologica,* **1.**

Mr. J. J. Hesling.—*Cereal-root eelworm.*

Dr. C. Ellenby.—*Self-control in the potato-root eelworm.*

Dr. C. L. Duddington and Mr. A. J. Juniper.—*Predaceous fungi and the biological control of nematodes.*

Population Genetics. (Joint Session with Section K (Botany):

Nature, **178,** 843–4 (Oct. 20, 1956).

Dr. J. M. Thoday.—*Heterogeneity of the environment and the genetic architecture of populations.*

Mr. J. A. Beardmore.—*Effects of diurnal temperature fluctuations on different* Drosophila *genotypes.*

Mr. J. Maynard Smith.—*Developmental flexibility in* Drosophila.

Cf. 'Acclimatisation to high temperatures in inbred and outbred *Drosophila, J. Genet.* **54,** 497–505.

Dr. H. Rees.—*The stability of meiosis in inbred and crossbred rye.*

Cf. Rees, H. (1955), 'Heterosis in chromosome behaviour', *Proc. roy. Soc.* B, **144,** 150–9; Rees, H. & Thompson, J. B., 'Genotypic control of chromosome behaviour in rye'; 'Chiasma frequency in homozygotes and heterozygotes', *Heredity* (in the press).

Dr. H. B. D. Kettlewell.—*The contribution of industrial melanism in moths to our knowledge of evolution (illustrated by a colour film).*

Cf. 'Selection Experiments on Industrial Melanism in the Lepidoptera', *Heredity,* Vol. **9,** Part 3, pp. 323–42 (December 1955); 'Further selection experiments on Industrial Melanism in the Lepidoptera', *Heredity* (in the press); 'Recognition of appropriate backgrounds by the pale and black phases of Lepidoptera', *Nature,* **175,** 943 (May 28, 1955); 'How industrialisation can alter species', *Discovery* (December, 1955); 'A resumé of investigations on the evolution of melanism in the Lepidoptera', *Proc. roy. Soc.* B, **145,** 297–304 (1956); 'Evolution in Progress', *Times Sci. Rev.* (1956).

September 4

The perception of complex patterns. (Joint Session with Sections I (Physiology) and J (Psychology):

Dr. P. Marler.—*Evolution of complex vocal signals in birds.*

Cf. 'Characteristics of some animal calls', *Nature,* **176** (1955) and 'Über die Eigenschaften einiger treulicher Rufe', *J. f. Ornith.* **97,** 220; 'The voice of the Chaffinch and its function as a language', *Ibis,* **98,** 231; 'The voice of the Chaffinch', *New Biology,* **20,** 70.

Mr. D. E. Broadbent.—*Some lessons from the perception of speech sounds.*

Mr. B. B. Boycott.—*Perception of pattern by octopus.*

Cf. Boycott, B. B. (1954), 'Learning in *Octopus vulgaris* and other cephalopods', *Pubbl. Staz. zool. Napoli,* **25,** 67–93; Boycott, B. B. & Young, J. Z. (1955), 'A memory system in *Octopus vulgaris* Lamarck', *Proc. roy. Soc.* B, **143,** 449–80; Boycott, B. B. & Young, J. Z. (1955), 'Memories controlling attacks on food objects by *Octopus vulgaris* Lamarck', *Pubbl. Staz. zool., Napoli,* **27,** 232–49; Boycott, B. B. & Young, J. Z., 'Reactions to shape in *Octopus vulgaris* Lamarck', *Proc. zool. Soc. Lond.* **126,** 491–548; Boycott, B. B. & Young, J. Z., 'Further effects of removal of the vertical lobe in *Octopus vulgaris* Lamarck', *Proc. roy. Soc.* B (in the press).

Dr. J. R. Smythies.—*Analysis of stroboscopic patterns.*

Mr. A. Brownlee.—*Higher nervous activity in domestic cattle.*

Cf. Brownlee, A. (1950), 'Studies on the Behaviour of Domestic Cattle in Britain', *Bull. Anim. Behav.* No. 8; Brownlee, A. (1954), 'Play in Domestic Cattle in Britain: An Analysis of its Nature', *Brit. vet. J.* **110,** 48

Dr. M. Lindauer.—*Communication in swarm-bees when they are looking for a new home.*

Mr. Bernard Venables.—*The natural history of angling.*

September 5

Dr. C. B. Goodhart.—*World population growth and its regulation by natural means.*

SECTION E

GEOGRAPHY

August 30

Prof. D. L. Linton.—*The Sheffield region.*

Cf. *Sheffield and its region,* O.U.P., 1956.

Mr. A. J. Hunt.—*The development of Sheffield.*

Cf. 'The morphology and growth of Sheffield', *Sheffield and its region,* O.U.P., 1956.

Dr. S. R. Eyre.—*The historical geography of the East Moor of north Derbyshire.*
To appear in *Trans. Inst. Brit. Geogr.* **23** (1957); cf. 'The curving plough-strip and its historical implications', *Agric. Hist. Rev.* **III,** Pt. II, 80 (1955).

August 31

The use and misuse of climatic resources, Presidential Address by Prof. A. Austin Miller.

Miss J. V. Aucott.—*The Peak District National Park.*

The Geography of the British Commonwealth:

Mr. H. Bowen-Jones.—*Malta—an interpretation of the cultural landscape.*

Mr. K. R. Sealy.—*Land use in Cyprus—an interpretation from air photographs.*

Mr. R. W. Steel.—*The copper belt of Northern Rhodesia.*
Expected to appear in *Geography.*

September 3

Climatology applied in the service of man:
Nature, **178,** 729–30 (Oct. 6, 1956).

Prof. Gordon Manley.—*Climatic fluctuations and heating requirements.*

Mr. M. Parry.—*Local climates and house heating.*

Dr. Alice Garnett.—*Atmospheric pollution in relation to some aspects of climate, relief and urban geography.*

Miss E. M. Frisby.—*Weather engineering in the service of industry.*

Mr. G. Melvyn Howe—*The estimation of water need and the water budget in England and Wales.*
Cf. 'The Moisture Balance in England and Wales based on the concept of Potential Evapo-transpiration', *Weather,* Vol. **XI,** No. 3 (March, 1956); 'The Water Budget in Wales', *Nature in Wales,* Vol. **2,** No. 3 (Autumn 1956).

Mr. S. Gregory.—*Some practical applications of British rainfall studies.*
Cf. 'Regional variations in the trend of annual rainfall over the British Isles', *Geogr. J.* **122,** 346 (1956).

Prof. B. J. Garnier.—*Climatic aspects of irrigation development in Nigeria.*

Mr. J. L. H. Sibbons.—*The climatic approach to evapo-transpiration.*

Discussion. Opened by Prof. P. R. Crowe.

September 4

Antarctic research. (See entry under Section C.)

Mr. R. A. G. Savigear and Mr. R. S. Waters.—*Techniques of morphological mapping.*

Social and economic geography:

Dr. G. Joan Fuller.—*Geographical aspects of the development of Santa Barbara, California.*

Dr. Harry Thorpe.—*A special case of heath reclamation in the Alheden district of Jutland, 1770–1955.*
See *Inst. Brit. Geographers: Trans.* 1957.

Mr. Leslie Symons.—*Economic change in the hill and marginal lands.*

Historical geography:

Mr. I. S. Maxwell—*The Domesday geography of the Sheffield area.*

Dr. H. C. K. Henderson.—*The agricultural geography of Derbyshire in the early nineteenth century.*

September 5

Studies in the geomorphology of Great Britain:

Miss G. E. Groom.—*The Raised Beach in south-west Wales.*

Mr. R. S. Waters.—*Differential weathering and erosion on 'oldlands'.*

Mr. R. A. G. Savigear.—*Observations on slope development.*

SECTION F

Economics

August 30

Mr. A. Hunter.—*The control of monopoly in Britain.*
Lloyds Bank Rev. No. 42 (Oct. 1956); cf. 'The Monopolies Commission and economic welfare', *Manchester School,* Jan. 1955; 'The Monopolies Commission and price-fixing', *Econ. Jnl.,* Sept. 1956.

Prof. Ian Bowen.—*Population and the social sciences.*

August 31

Prices—and competition—in transport as an instrument of policy, Presidential Address by Prof. Gilbert Walker.

Mr. E. T. Sara.—*Progress in the U.K. Iron and Steel industry.*
Iron and Coal Trades Rev., Sept. 14, 1956; cf. 'British and Foreign Steel Prices', *Times Rev. of Industry.* June, 1953.

September 3

The general aspects of automation. (See full entry under Section G):

Prof. H. D. Dickinson.—*The economic effects of automation.*
Engineering, Sept. 14, 1956, p. 337.

Mr. A. D. Peel.—*Current transport problems as seen by the Transport Manager.*

September 4

Mr. E. Rudd.—*Expenditure on scientific research and technical development in Britain and America.*

Prof. Bruce Williams.—*Innovation.*

Education for industrial administration:

Prof. R. W. Revans.—*University education for industrial administration.*

Mr. D. H. Bramley.—*The place of part-time courses in education for administration.*

Mr. D. R. O. Thomas.—*Industrial requirements in the teaching of management subjects.*

SECTION G
ENGINEERING
August 30

Oil and Industry, Presidential Address by Mr. A. C. Hartley, C.B.E.

Papers by Young Engineers:

Mr. R. G. George.—*Control flux wave form in the tracing of dynamics hysteresis loops.*

Mr. J. McNeillis.—*A review of boiling heat transfer with particular reference to unstable flow.*

Mr. D. P. Blight.—*Measurements of the velocity and deposit patterns of dust clouds.*

Mr. M. G. Perry.—*A simple method for automatic control of secondary air in combustion.*

August 31

Session A

Dr. W. Hume-Rothery, O.B.E., F.R.S.—*Solid solutions in iron.*

Mr. H. E. Gresham.—*High temperature alloys.*

Mr. L. D. Brownlee.—*Powder metallurgy.*

Session B

Dr. D. F. Galloway.—*Improving cutting tool performance by practical research.*

Prof. D. Christopherson, Dr. W. B. Palmer and Mr. P. L. B. Oxley.—*The orthogonal cutting of a work-hardening material.*

Mr. H. Ll. D. Pugh and Mr. A. J. Chisholm.—*The mechanics of the metal cutting process.*

September 3

General aspects of automation. (Joint Session with Section F (Economics):

The Rt. Hon. the Earl of Halsbury.—*Introduction.*

Mr. J. F. Coales, O.B.E.—*The scientific background of automation.*

Engineering, Sept. 28, 1956.

Session A

Prof. H. D. Dickinson.—*Economic effects of automation.*

Session B

Prof. F. S. Atkinson, Mr. W. H. Sansom, M.C., O.B.E., and Mr. A. Scott.—*Problems and achievements in coal face mechanisation.*

To appear in *Engineering*.

September 4

Session A

Automation (continued from September 3):

Mr. A. J. Young.—*Automatic control of processes.*

Mr. D. T. N. Williamson.—*Computer controlled machine tools.*

Dr. D. Taylor.—*Atomic energy and automation.*

Engineering, Sept. 7, 1956, pp. 306–7.

Mr. J. Sargrove.—*'Conscious' machines* (illustrated by a film).

Cf. 'Automatic inspection—the anatomy of conscious machines', *J. Inst. Prod. Engrs*, 1955 (Margate Conference number); 'Optical transducers and some industrial applications', *J. Br. Inst. Radio Engrs*, Aug. 1954.

Session B

Prof. J. A. Pope with Mr. B. K. Foster and Dr. N. T. Bloomer.—*Limited life design—a survey of the problem.*

To appear in *Engineering*.

Dr. A. D. Booth.—*The use of electronic machinery for the translation of language.*

Engineering, **182**, No. 4722, 302–4 (Sept. 1956).

Session C

Utilisation of fuels. (See entry under Section A.)

September 5

The properties of magnetic materials. (See entry under Section A.)

SECTION H
ANTHROPOLOGY AND ARCHAEOLOGY
August 30

Archaeology of the Sheffield region:

Mr. M. Posnansky.—*The Lower and Middle Palaeolithic Cultures of the East Midlands.*

Mr. A. L. Armstrong, M.C.—*The Middle and Upper Palaeolithic cultures of the North Midlands.*

Mrs. M. Fowler.—*The transition from Neolithic to Bronze Age in the Derbyshire limestone district.*

Prof. I. A. Richmond.—*The lower basin of the Yorkshire Ouse in Roman Times.*

Mr. F. H. Thompson and Mr. G. Russell Coope.—*Stone implement petrology in the North-West of England.*

Mr. L. H. Butcher.—*The Quern workings on Wharncliffe, near Sheffield.*

August 31

Blood groups and anthropology. (Joint Session with Sections D (Zoology) and I (Physiology)):

Blood Groups and human evolution, Presidential Address by Dr. A. E. Mourant.

Dr. J. A. Fraser Roberts.—*Associations between blood groups and disease.*

Dr. M. J. R. Healy and Dr. J. M. Tanner.—*The genetics of human morphological characters.*

Dr. D. F. Roberts.—*The distribution of some human serological characters in Africa.*

Mr. H. W. M. Hodges.—*Blood groups and archaeology.*

Mr. John V. Evans.—*Blood groups in ruminants and human migration.*

Evans, J. V. (1954), 'Electrolyte concentrations in red blood cells of British breeds of sheep', *Nature*, **174**, 931; Evans, J. V. (1956), 'Electrolyte haemoglobins and other differences in the red blood cells of sheep', Abstr. XXth Int. Physiol. Congr. p. 278; Evans, J. V. (1956), 'The stability of the potassium

concentration in the erythrocytes of individua sheep compared with the variability between different sheep', *J. Physiol.* (in the press); Evans, J. V. & King, J. W. B. (1955), 'Genetic control of sodium and potassium concentrations in the red blood cells of sheep', *Nature*, **176**, 171; Evans, J. V., King, J. W. B., Cohen, B. L., Harris, H. & Warren, F. L. (1956), 'The genetics of haemoglobin and blood potassium differences in sheep', *Nature*, **178** (in the press.); Evans, J. V. & Mounib, M. S. (1956), 'A survey of the potassium concentration in the red blood cells of British breeds of sheep', *J. agric. Sci.* (in the press).

Dr. Ada Kopeć.—*Blood groups in Great Britain.*

Mr. Roland Jones.—*Blood groups in South Wales.*

Discussion on the general theme.

Summing-up and concluding remarks by Dr. N. A. Barnicot.

September 3

Technology of ancient glass and metal (*General theme*):

The technology of ancient glass and glass-making:

Dr. D. B. Harden, O.B.E.—*Ancient glass furnaces.*

Prof. W. E. S. Turner, O.B.E., F.R.S.—*The raw materials and composition of ancient glasses.*

Cf. 'Studies in Ancient Glasses and Glass-making Processes'. Part III, 'The Chronology of the Glassmaking Materials', *J. Soc. Glass Tech.* **40** (Feb. 1956); Part IV, 'The Composition of Ancient Glasses', *J. Soc. Glass Tech.* **40** (April 1956); Part V, 'The Raw Materials for Glassmaking', *J. Soc. Glass Tech.* **40** (June 1956).

Mr. E. M. Jope.—*The analysis of ancient glasses.*

Mr. Ray W. Smith.—*A research programme on ancient glass.*

September 4

General theme (*continued from September* 3): *Technology of ancient metal:*

Prof. W. G. Fearnsides, F.R.S.—*Distribution of metalliferous ores.*

Prof. F. C. Thompson.—*Mining, extraction, refining and casting.*

Mr. H. Maryon.—*Fashioning of metal artefacts.*

Mr. H. W. M. Hodges.—*Studies of ancient metalworking techniques.*

Mr. J. W. Anstee.—*Pattern-welded iron swords.*

Mr. H. H. Coghlan.—*Scientific evidence about provenance of early implements.*

Dr. E. Voce and Mr. L. Biek.—*Scientific evidence about metalworking techniques.*

Prof. V. Gordon Childe.—*Archaeological significance of metalworking techniques.*

Mr. T. W. Farrer.—*Scientific evidence from ancient artefacts as related to conditions of burial.*

September 5

General theme: Technology of ancient glass and metal (*concluded*):

Mr. L. Biek.—*Summing-up of general theme*, followed by discussion.

SECTION I

PHYSIOLOGY

August 30

Taste, appetite and the selection of food:

Prof. Y. Zotterman.—*Introduction: electrophysiological investigations on the functions of gustatory nerve fibres.*

Dr. J. G. Gordon.—*Palatability in relation to physiological needs.*

Dr. R. Harper.—*Psychological aspects of food acceptance.*

Cf. 'Food grading and its study', *Food*, **18**, 207–10 (1949); 'Assessment of food products', *Food*, **19**, 371–5 (1950); 'The assessment of foodstuffs', *Dairy Industries*, **19**, 307–12 (1954); 'Food facts and food fancies', *Nutrition*, **8**, 160–72 (1954); Fundamental problems in the subjective appraisal of foodstuffs', *Applied Statistics*, **4**, 145–60 (1955).

Dr. H. N. Munro.—*Time factors in nutrition.*

Cf. *Scottish Med. J.* **1**, 285–93, by H. N. Munro.

August 31

Blood groups and anthropology. (See entry under Section H.)

Respiratory pigments:

Nature, **178**, 721–2 (Oct. 6, 1956).

Prof. Q. H. Gibson and Prof. F. J. W. Roughton, F.R.S.—*Recent work on the physical chemistry of haemoglobin.*

Dr. V. M. Ingram.—*Studies on the structure of the haemoglobin molecule.*

Cf. 'A specific chemical difference between the globins of normal human and sickle cell anaemia haemoglobin', to appear in *Nature.*

Prof. Q. H. Gibson.—*Application of flash photolysis methods to haemoglobin kinetics.*

Prof. F. J. W. Roughton, F.R.S.—*Gas exchange in the human lung.*

September 3

The machinery of posture:

The machinery of posture, Presidentia Address by Prof. D. Whitteridge, F.R.S.

Miss Violet R. Cane and Mr. R. L. Gregory.—*Sensory discrimination as a statistical problem for the brain.*

Cf. Gregory, R. L. & Cane, Violet (1955), 'A Statistical Information Theory of Visual Thresholds', *Nature*, **176**, 1272; Gregory, R. L. (1955), 'An Experimental Treatment of Vision as an Information Source and Noisy Channel', *Information Theory: Third London Symposium*, ed. Colin Cherry, Butterworth; Gregory, R. L. (1955), 'A note on Summation Time of the Eye Indicated by Signal/Noise Discrimination', *Quart. J. exp. Psychol.* **7**, 147.

Dr. P. A. Merton.—*Eye movements.*

September 4

Perception of complex patterns. (See entry under Section D.)

Polar physiology:

Dr. O. G. Edholm.—*Polar physiology.*

Dr. H. E. Lewis.—*Physiological effects of polar environment.*

Dr. J. P. Masterton.—*Nutrition and energy expenditure during a polar expedition.*

Dr. Mary Lobban.—*Studies on physiological diurnal rhythms in polar regions.*

Cf. (*a*) *Scientific publications*—Lewis, P. R. & Lobban, Mary C. (1954), 'Persistence of a 24 hr. pattern of diuresis in human subjects living on a 22 hr. day', *J. Physiol.* **125,** 34–35p; Lewis, P. R. & Lobban, Mary C. (1955), 'Electrolyte excretion in human subjects living on a 22 hr. day', *J. Physiol.* **128,** 44–45p; Lewis, P. R. & Lobban, Mary C. (1956), 'Dissociation of diurnal rhythms in human subjects living on abnormal time routines'. Abstract published in the proceedings of the International Physiological Congress, Brussels, July, 1956.

(*b*) *A more general account*—Lobban, Mary C. (1956), 'The Cambridge Spitzbergen Physiological Expeditions, 1953 and 1955'. The Magazine of the Cambridge University Medical Society, **33,** No. 2, 3–8.

Mr. R. J. F. Taylor.—*A study of sledge dogs.*

Dr. P. Massey.—*Acclimatisation to cold.*

Dr. A. F. Rogers.—*The programme of physiological work for the Trans-Antarctic Expedition, 1955–1958.*

September 5

Energy expenditure:

Dr. R. Passmore.—*Methods of determining input and output of energy.*

Dr. O. G. Edholm.—*Energy expenditure.*

Dr. J. D. Pullar.—*Energy expenditure in livestock.*

SECTION J

PSYCHOLOGY

August 30

Dr. C. M. Franks.—*The influence of drugs and other variables upon the perception of the upright.*

Science News Letter, **70,** No. 10 (Sept. 8, 1956).

Mrs. P. K. Thornton.—*Visual perception among the peoples of Malaya.*

Miss M. D. Allan.—*Training in perceptual skills.*

To appear in *J. occup. Psychol.*

Psychology and the humanists, Presidential Address by Prof. J. Drever.

Dr. N. O'Connor.—*The social effectiveness of the mentally handicapped.*

Dr. P. Kräupl Taylor.—*Collective emotions and mental epidemics.*

Mr. A. McGhie.—*The role of the mental nurse.*

Cf. Patient and nurse—effects of environmental changes in the care of chronic schizophrenics, *Lancet,* Dec. 31, 1955; Dr. T. Freeman & A. McGhie, 'The state of the ego in chronic schizophrenia', to appear in *Br. Med. J. Psychol.,* Jan. 1957.

Dr. Peter McKellar.—*The application of science to human living.*

August 31

Vigilance—the nature of alertness and the problem of its maintenance during long spells of work:

Dr. N. H. Mackworth.—*Some factors affecting vigilance.*

Mr. E. Elliott.—*Auditory vigilance tests.*

Mr. D. E. Broadbent.—*The vigilant man and the active man.*

Dr. D. H. Irvine.—*Visual inspection as a vigilance task.*

Cf. 'An experimental study of human variability in a task involving visual inspection', (Ph.D. Thesis, Birkbeck Coll., Oct. 1955); *Proc. 13th Int. Congress of Psychol.,* Stockholm, 1951.

Discussion. Opened by Mr. D. Wallis.

Dr. P. H. Mann.—*Community and social class.*

Dr. Michael Young.—*Kinship and community in East London.*

Mr. W. A. Belson.—*The effects of television.*

Mr. Cyril Greenland.—*Advice columns of the national press in 1953.*

September 3

Problems of maladjusted children. (Joint Session with Section L (Education):

Dr. E. M. Bartlett.—*The Report of the Committee on Maladjusted Children.*

Mr. W. J. Deacon.—*The Education Authorities.*

Mr. Otto L. Shaw.—*The parents of maladjusted children.*

Mr. Noel E. Whilde.—*The work of the educational psychologist.*

Dr. R. F. Barbour.—*The maladjusted child.*

Discussion. Opened by Miss M. A. Davidson.

September 4

The perception of complex patterns. (See entry under Section D.)

Miss R. Stewart.—*Educational background and career history of 3,300 British managers.*

Cf. *Management Succession,* Chapters 1 and 2, Acton Society Trust, 1956.

Dr. C. Sofer.—*The methodology of a collaborative research project.*

Mr. O. W. Reynolds and Mr. D. R. O. Thomas.—*Problems of adjustment to conditions of industrial employment of boys of 15 to 18 years of age.*

Mr. R. Edwards.—*A university contribution to training for management.*

Mr. R. A. M. Gregson.—*Interrelation of attitudes and communications in a subdivided working group.*

Dr. H. D. Wing.—*The measurement of musical aptitude.*
Times Ed. Suppl., Sept. 7, 1956, p. 1095; cf. 'A Factorial Study of Musical Tests', *Brit. J. Psych.* **31** (1941); 'Tests of Musical Ability and Appreciation', *Brit. J. Psych.* (Mon. Suppl.) (1948); *The Seashore Measures*, revised edition, Fourth Mental Measurement Year Book (1953); 'Musical Aptitude and Intelligence', Essex Education, County Offices, Chelmsford (July and August 1954); 'Some Application of Test results to Education in Music', *Brit. J. Psych.* **24,** 161 (1954).

Dr. M. M. Clark.—*Learning to count.*

Mr. J. Macdonald.—*Social class patterns in intelligence test responses.*

Dr. J. A. H. Lee.—*The educational achievements of a group of young men.*

SECTION K
BOTANY
August 30

Quaternary history and the British flora, Presidential Address by Dr. H. Godwin, F.R.S.

Mr. G. F. Mitchell.—*The late glacial vegetation of the Isle of Man.*

Miss Anne Conolly.—*Late glacial plants from Whitrig, Scotland.*

Dr. D. Walker.—*Mesolithic artefacts stratified in Pennine peat.*

August 31

Decay of plant litter. (Joint Session with Sub-Section K* (Forestry):

Dr. J. G. Boswell.—*Observations on some natural soils.*

Dr. J. Webster.—*'The grass withereth.'*
To appear in *J. Ecol.*, July and Dec., 1956.

Dr. P. W. Murphy.—*The rôle of Soil Acarina in the decomposition of leaf litter.*

Dr. J. D. Ovington.—*The importance of litter breakdown in the woodland ecosystem.*

Salt uptake by plants:
Nature, **178,** 897–9 (Oct. 27, 1956).

Dr. James Sutcliffe.—*Salt accumulation in storage tissues.*

Dr. L. J. Middleton and Dr. Scott-Russell.—*The significance of ionic interactions in active transport.*

Dr. A. B. Hope.—*The uptake of mixtures of cations.*

Dr. J. L. Harley.—*Factors affecting salt absorption by beech roots.*

September 3

Genetics of micro-organisms. (Joint Session with Section D (Zoology):

Prof. D. G. Catcheside, F.R.S.—*Introduction.*

Dr. G. H. Beale.—*Genetics of the antigens of* Paramecium.

Dr. C. Quadling.—*Bacterial motility and cellular variation.*
Cf. Quadling, C. (1956), Ph.D. Thesis, University of London: 'The genetic environmental determination of bacterial motility, with special reference to *Salmonella*.'

Mr. S. W. Glover.—*Transduction of biochemical mutants of* Salmonella.

Mr. K. McWhirter.—*Genetic latency in inherited viruses and its significance for evolution.*

Population Genetics. (Joint Session with Section D (Zoology):
(For refs. see entry under Section D.)

Dr. J. M. Thoday.—*Heterogeneity of the environment and the genetic architecture of populations.*

Mr. J. A. Beardmore.—*Effects of diurnal temperature fluctuations on different* Drosophila *genotypes.*

Mr. J. Maynard Smith.—*Developmental flexibility in* Drosophila.

Dr. H. Rees.—*The stability of meiosis in inbred and crossbred Rye.*

Dr. H. B. D. Kettlewell.—*The contribution of industrial melanism in moths to our knowledge of evolution.*

September 4

Ecology of the Sheffield district:

Prof. A. R. Clapham.—*Pioneer vegetational studies in the South Pennines.*

Dr. C. D. Pigott.—*Plant geographical and ecological features of the flora of the Derbyshire limestone.*

Mr. F. Haynes.—*Soil development on the Derbyshire limestone.*

Prof. A. R. Clapham and Mr. D. Ratcliffe.—*Therophyte communities on the Derbyshire limestone.*

Dr. A. Melderis.—*Botanical expedition to West Greenland.*
Expected to appear in *J. Linn. Soc.*, 1957.

September 5

Mr. J. L. Franks.—*Neolithic forest clearance in the Lake District.*

Dr. J. Brierley.—*Ecology of pit heaps.*

Miss Olive Balme.—*Species distribution in relation to soil profile on the Derbyshire limestone.*
Cf. 'Edaphic and Vegetational Zoning on the Carboniferous Limestone of the Derbyshire Dales', *J. Ecol.* Vol. **41,** No. 2 (Aug. 1953); '*Viola lutea*', *J. Ecol.* Vol. **42,** No. 1 (Jan 1954).

Dr. J. Warren Wilson.—*Arctic plant growth.*

SUB-SECTION K*
FORESTRY
August 30

Current trends in forest research in Britain, Chairman's Address by Mr. M. V. Laurie, O.B.E.

August 31

Decay of plant litter. (See entry under Section K.)

September 3

Afforestation of water catchment areas:

Mr. R. W. S. Thompson.—*A waterworks forestry scheme.*

Mr. Frank Law.—*The effect of afforestation upon the yield of water catchment areas.*

Mr. A. Bleasdale.—*Afforestation of water catchment areas.*

September 4

Forestry in industrial areas—smoke pollution: *Nature*, **178**, 719–21 (Oct. 6, 1956).

Mr. A. J. Grayson.—*Air pollution as it affects forestry.*

Mr. E. M. Conder.—*Some problems of private forestry in the industrial areas.*

Dr. P. F. Wareing.—*Atmospheric pollution and plant growth.*

Dr. G. Scurfield.—*Atmospheric pollution.*

SECTION L

Education

August 30

The impact of British education on the indigenous peoples of oversea territories, Presidential Address by Sir Christopher Cox, K.C.M.G.

Miss J. E. Richardson.—*Human relations in education.*

August 31

Television and schools. (See entry under Assembly of Corresponding Societies.)

Mr. J. W. L. Adams.—*The Universities and managerial education.*

Prof. W. H. G. Armytage.—*Aspects of American influence on British Education.*

Education and productivity in underdeveloped territories:

Prof. F. C. Benham, C.M.G., C.B.E.—*Allocation of resources.*

Mr. J. C. Jones, C.B.E.—*Right perspectives in technical education.*

Mr. P. C. C. Evans.—*Western schooling and rural productivity.*

Mr. R. K. A. Gardiner.—*Fundamental education and economic advancement.*

September 3

Problems of maladjusted children. (See entry under Section J.)

Science as part of a general education:

J. A. Ratcliffe, O.B.E., F.R.S.—*Can science courses educate?*

Dr. R. C. Smail, M.B.E.—*Can arts courses be combined with science courses?*

September 4

The central educational dilemma in underdeveloped territories: quality or quantity?

Mr. E. W. Woodhead.—*The problem of priorities.*

Sir James Robertson, O.B.E.—*The demand for higher education.*

Miss F. H. Gwilliam. O.B.E.—*The challenge of teacher training.*

Mr. P. M. Sherlock, C.B.E.—*National aspirations.*

September 5

The voluntary factor in education and the lay contribution:

Mr. Frank Barraclough, C.B.E.—*The lay contribution.*

Education, Sept. 14, 1956.

The Rt. Rev. the Lord Bishop of Peterborough, Dr. R. W. Stopford, C.B.E.—*The voluntary factor.*

SECTION M

Agriculture

August 30

The influence of man on soil fertility, Presidential Address by Mr. G. V. Jacks.

Tropical Agriculture:

Mr. H. J. Page, C.M.G., O.B.E.—*Applied agricultural science in the tropics.*

Mr. Grahame Williamson, C.B.E.—*Tropical livestock development.*

August 31

Effects on agriculture of changes in the balance of nature:

Nature, **178**, 565–6 (Sept. 15, 1956).

Mr. E. M. Nicholson, C.B.—*Ecological research and farming.*

Nature, **178**, 175–7; to appear also in *Agriculture.*

Dr. I. Thomas.—*Natural and artificial control of vertebrate pests of agriculture.*

Mr. A. H. Strickland.—*Insect pest balance in agriculture.*

September 3

Recent advances in animal nutrition:

Dr. G. E. Lamming.—*The addition of antibiotics and hormones to animal feeds.*

Mr. D. S. MacLusky.—*The rôle of grass in feeding the dairy herd.*

J. Roy. Agric. Soc. of England, Dec. 1956.

Mr. R. C. Campling.—*A comparison of extensive and intensive grazing methods.*

September 4

Agricultural engineering—future prospects:

Mr. D. R. Bomford.—*The further mechanisation of agriculture: its difficulties and possibilities.*

Mr. A. W. Capps.—*Heat husbandry techniques applied to the small farm.*
Farmers' Weekly, p. 50, Sept. 7, 1956; *Farm Implement and Machinery Review*, Nov. 1956.

Mr. H. J. Hamblin.—*The motive power of the future.*
To appear in *J. Agric. Eng.* **1,** No. 3 (Jan. 1957); cf. 'The application of hydrostatic transmission to tractors', *J. Instn Brit. agric. Engrs*, **12,** No. 3.

SECTION X

Assembly of Corresponding Societies

August 30

Local Societies in the community of today, Presidential Address by Dr. F. J. North, O.B.E.

Mr. Harold A. Hems.—*Some problems of the nature photographer* (illustrated by colour film).

Mr. J. James Swift—*Bee-eaters in Britain.*

August 31

Television and schools:

Dr. Hilde T. Himmelweit.—*Problems of research into the effect of television on children.*

Miss B. R. Winstanley.—*The potentialities of television as a medium in the education of children.*
Education, Sept. 21, 1956.

Mr. H. G. Hurrell.—*The Pine Marten.*
Cf. 'My Pine Marten', H. G. Hurrell, *Countryman*, Spring, 1956.

Dr. Trevor D. Ford.—*The Blue John Stone of Castleton, Derbyshire.*
Proc. Yorks. geol. Soc., **30,** Pt. 1 (Sept. 1955).

September 3

General discussion of Presidential Address, opened by Prof. A. R. Clapham.

Mr. S. D. Cleveland, O.B.E.—*The artist and the countryside.*

September 4

Science, by the upper form:
Nature, **178,** 670–1 (Sept. 29, 1956).

Mr. Anthony E. Hanwell.—*The history of science in a sixth-form science course.*

Mr. Kenneth R. Hughes.—*British Finches.*

Miss Anne Bunting.—*Some little-known and unpublished aspects of the life history and habits of* Periplaneta americana.

Mr. Keith L. Watson.—*The Charterhouse astronomical project.*

Mr. John K. Chesters.—*The ecology of Porter Brook.*

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August 29th—September 5th, 1956

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CORRIGENDUM

In the Presidential Address entitled 'Prices—and Competition—in Transport as an instrument of Policy', by Professor Gilbert Walker (*Advancement of Science*, **XIII,** No. 50, p. 75), line nine, the text should read '. . . the motorist wanting to park does not know how much . . .'.